1950

NEW ZEALAND

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(TWENTY-FOURTH ANNUAL REPORT OF THE)

Presented to Both Houses of the General Assembly by Leave

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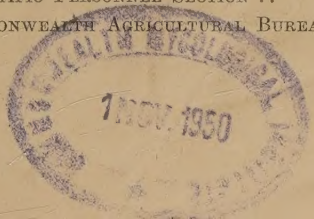

MINISTER'S STATEMENT

THE report of the Department of Scientific and Industrial Research for the financial year ended 31st March, 1950, is presented herewith.

The Secretary's report refers in particular to the effects of inadequate accommodation on the work of the Department, to recruitment and salaries, to building research, to the further development of food research, and to the utilization of our resources of ironsand. Attention is also drawn to the technological assistance that has been rendered to industry particularly through Research Associations. Mention is made of the Department's relationships with scientific organizations in Commonwealth and other countries overseas, and the importance is stressed of maintaining continuous and effective contact between scientific workers in this country and workers in similar fields overseas.

The reports of the Department's Branches and Research Committees, of Research Associations, and of organizations operating under grants is set out in the main section of the report in some detail.

It remains for me to add that the maintenance of highly efficient scientific services and research organizations are essential to the good government of the country and to the most effective development of the Dominion's natural resources. The increased extent to which primary producers and industrialists alike are seeking and applying the results of research is one of the most encouraging features of our economic life.

One of the most important factors in our efforts to increase our standard of living is the extent to which we are prepared to encourage scientific research and services; equally important is the extent to which we utilize the results.

K. J. HOLYOAKE,

Minister in Charge of the
Department of Scientific and Industrial Research.

SECRETARY'S REPORT

The Hon. K. J. Holyoake, Minister in Charge of the Department of Scientific and Industrial Research.

I have the honour to submit herewith the annual report of the Department for the year 1949–50.

Previous reports have drawn attention to the unsatisfactory conditions in which the staff of many Branches of the Department are accommodated. I regret to state that, despite the fact that every effort has been made to improve conditions, results have been disappointingly small. Building costs are at an inordinately high level, and the shortage of skilled labour is such as to accentuate every difficulty associated with accommodation. This state of affairs has persisted so long that it is markedly affecting the efficiency of certain Branches of the Department and is developing in their staffs a sense of frustration. This is a matter of grave concern. Conditions are particularly bad in the Dominion Laboratory, Grasslands Division, Geological Survey, Soil Bureau, and Botany Division, yet despite this the staffs of these Branches have continued to give good service.

During the year recruitment of staff has been kept to a minimum, a policy justified by shortage of accommodation and the need for consolidation following a period of expansion. The Department's requirements are for men possessed of first-class qualifications in their subjects, with powers of resource, initiative, and leadership. It is most necessary to build up a reputation in those spheres of scientific endeavour appropriate to the needs of the Dominion. This can best be initiated by the employment of first-class leaders who will attract others similarly qualified and interested. It has been amply shown to be sound policy in the organization of research to strive to secure first-class men rather than to be content with a larger number of mediocre ability. With these ideas in mind, considerable and careful attention has been given during the year to the introduction of a scheme of assessing scientific ability and effectiveness and relating this to promotion. I am pleased to record that these proposals have been favourably received by the Public Service Commission, which has agreed to their adoption experimentally. I have every confidence that should the scheme be finally adopted in its entirety it will exert a very beneficial influence in the maintenance of a high standard of attainment in the staff of the Department, and will provide full encouragement to those who make efforts to improve their standard of efficiency. It will also do something towards raising salaries of New Zealand scientific workers so that the large gap which has long existed between these and the salaries paid in other parts of the Commonwealth will be reduced.

Recognition of the scientific calibre of two members of the staff came from overseas during the year. Dr. G. H. Cunningham, Director of the Plant Diseases Division, was elected an F.R.S., and Dr. F. B. Shorland, Director of the Fats Research Laboratory, was awarded the degree of D.Sc. of the Liverpool University.

It is a matter for regret that no progress can yet be reported on the establishment of an organization to deal with building and civil engineering research, which was reported on originally by Sir Reginald Stradling in 1947. Meantime, various Branches of the Department have continued to deal with the many immediate problems arising in this sphere. This, however, cannot be regarded as an adequate substitute for a properly organized building and civil engineering research effort. There are many short and long-range problems affecting the building and engineering fields in New Zealand which require scientific attention. Substantial benefits could be derived from the expenditure on research of a very small percentage of the amount (some £50,000,000) spent annually by the industry. In the immediate future the question of erection of large buildings of permanent materials will arise, and in a country liable to earthquakes and with little fundamental knowledge of its building materials, the need for research and scientific study can hardly be over-emphasized. Even though the results of overseas research and experience can readily be secured by the Department there still remains the need to apply these results locally and explore the possibilities of New Zealand materials.

It is appropriate in a country as dependent for its prosperity on the production of perishable foodstuffs as is New Zealand that scientific attention should be devoted to food research. During the year a distinct forward move was made in the establishment in the Dominion Laboratory of a small Meat Research Section, where attention is being devoted to various prob'ems, including the storage and transport of meat. When staff now in training overseas become available the work in this sphere will, it is hoped, be extended, for it has too long been inadequately covered.

As the result of renewed interest in the Dominion's resources of raw material for the iron and steel industry, a reconnaissance survey of the titaniferous and magnetic ironsands occurring in the western beaches of both Islands was made. It revealed that the tonnage of ore present in these deposits is very large and capable of providing adequately for the needs of an industry if only the technical and economic problems of extracting the metal could be solved. In association with the Department of Industries and Commerce some attention during the year has been given to the concentration of the sand and to its extractive treatment in an electric furnace.

A pleasing feature of the year has been the progressive development of interest in Research Associations for the manufacturing industries. Several proposals have been received for the establishment of new Associations and the extension of existing ones. This is a very encouraging sign, seeing that the interest has arisen at a time when some of the existing Associations have been facing very serious difficulties in respect to both staff and accommodation. It is evident that the Department's efforts to provide scientific help for New Zealand manufacturing industries is being appreciated, and that the association type of organization, in which representatives of industry actively participate in the financing and managing of the research done on their behalf, is sound and appeals to industrialists.

The work of the Department must be regarded against the background of advance in world science to-day. The tempo of this advance has been greatly increased in recent years and there is no sign of any slackening. Scientific organization throughout the Commonwealth is such that New Zealand is kept in touch with new developments and progress. There are regular exchanges of reports and scientific literature with kindred State

Departments in all parts of the Commonwealth, the U.S.A., and a number of other foreign countries, and in some fields there is direct and active collaboration. The Scientific Liaison staffs of the Department in London, Washington, and Melbourne play a most important part in keeping New Zealand abreast of overseas developments and in promoting contacts which are to the advantage of scientific progress locally. Nevertheless, however good are the results accruing from all these means of collaboration—and the results are good indeed—there is still something lacking which can be supplied only by direct personal contact and exchange of ideas between scientific workers in New Zealand and their fellow-workers overseas. It is most important, therefore, that a policy should be pursued whereby numbers of selected scientists are each year sent overseas to study and acquire inspiration and techniques from their counterparts in other lands where experience is longer and facilities greater than they are in New Zealand.

The value of personal contact with scientific workers overseas is fully recognized in other Commonwealth countries, and I strongly recommend adherence to a policy whereby scientists in New Zealand are afforded opportunities of meeting and working with their fellows overseas. There is evidence that such a policy pays handsome dividends.

There always remains the problem of the appropriateness and adequacy of the research and scientific work actually being done in New Zealand. Are present efforts inadequate or out of balance or disproportioned? Are fields being neglected in which the assistance of science would bring considerable advantage? These are questions which continually concern the administrative officers of the Department, and in which they receive valuable guidance from the Council of Scientific and Industrial Research, which constantly keeps under review the Department's activities, and which provides the Department with helpful and greatly appreciated constructive criticism. It is fitting here that I pay tribute to the Council of Scientific and Industrial Research for the important role it undertakes and the very real help its guidance has been to the Department. It is equally appropriate to acknowledge the debt which the Department owes to the Advisory Committees of the Council for the constant effort they have devoted very effectively in the best interests of the work with which they have been directly concerned.

RESEARCH COUNCIL

The Research Council met on five occasions during the year; in addition, there have been many committee meetings.

The membership of the Council is as follows:—

T. Rigg, K.B.E., M.A., M.Sc., F.R.I.C., F.R.S.N.Z. (Chairman).
J. C. Andrews, Ph.D., M.Sc. (Deputy Chairman).
N. L. Edson, B.Med.Sc., M.B., Ch.B., Ph.D. (Cantab.).
E. J. Fawcett, M.A. (Cantab.).
E. R. McKillop, O.B.E., M.I.C.E.
R. O. Page, D.Sc.
J. M. Ranstead, Bledisloe Medallist.
W. Riddet, B.Sc. (Agric.), N.D.A., N.D.D.
D. F. Sandys Wunsch, M.A. (Oxon.), B.Sc. (McGill), M.I.Chem.E., Assoc.Inst.M.M.
F. R. Callaghan, M.A., F.R.E.S. (Secretary).

EXPENDITURE, 1949–50

The net expenditure for the year amounted to £877,987. The following was the expenditure incurred in the various branches of the Department:—

	£
Head Office	51,259
Research investigations	313,071
Dominion Laboratory	119,121
Geological Survey	92,661
Observatories	40,892
Dominion Physical Laboratory	173,446
Grants to University and Agricultural Colleges	38,887
Grants to Research Associations	27,662
Grants, statutory and miscellaneous	4,786
Grants to allied institutions in the United Kingdom	7,530
Information Bureau, Scientific Liaison Services, and miscellaneous services	63,049
Auckland Industrial Development Laboratories	26,386
	958,750
Less recoveries	80,763
Net expenditure	£877,987

STAFF

The number of staff of the Department and its disposition at the 31st March, 1950, was as follows:—

Agronomy, Botany, Entomology, Grasslands, and Plant Diseases Divisions	173	Fats Research Laboratory	21
Auckland Industrial Development Laboratories	29	Geological Survey	75
Dominion Laboratory and district Branches	151	Head Office (including Information Bureau and district offices)	133
Dominion Physical Laboratory	198	Observatories	42
		Soil Bureau	74
		Miscellaneous	86

Total staff, including clerical officers, typists, technicians, and professional officers: 982 (945 permanent and 37 temporary). These comprise; professional 381; clerical, 163; technical, 438.

CONCLUSION

A particularly valuable and encouraging feature of the work is the very close and cordial relationships which exist between the Department and other Government Departments, the University of New Zealand and its constituent colleges, the Cawthron Institute, other research organizations, and industry generally.

The continued loyal and efficient service rendered by all members of the Department is sincerely appreciated.

F. R. CALLAGHAN, Secretary.

REPORTS FROM BRANCHES

AGRONOMY DIVISION

Director: Mr. J. W. Hadfield
Associate Director: Dr. O. H. Frankel

The amalgamation of the Agronomy Division and the wheat-breeding section of the Wheat Research Institute takes effect on 1st April, 1950. Located at Lincoln, both are concerned with crop improvement and use similar facilities. In future, improvement of all field and vegetable crops will be looked after by this organization, which has been named the Crop Research Division.

PURE-SEED PRODUCTION

Management of Experimental Area.—The production of the nucleus seed of standard varieties—usually an acre or two each—has by agreement been taken over by the Department of Agriculture, and the effect of this change will be threefold. Firstly, it will arrest the depletion of soil fertility brought about by heavy cropping since 1936; of the five 20-acre blocks now formed, there will be three under recuperative pasture, one under autumn-sown, and one under spring-sown experimental plots. Secondly, it will bring about a much greater uniformity in the utilization of the area, and hence in its soil conditions. Thirdly, it will free space, staff, and resources for intensive research in crop improvement.

The early stages in the production of pure seed, requiring small areas only, remain a responsibility of the Crop Research Division, as does, for the time being, the seed-dressing of the nucleus lines produced by the Department of Agriculture.

DISEASE RESISTANCE

Diseases and insect pests take a heavy toll of many of our crop plants: seed treatment is an effective and, on the whole, inexpensive defence against some of these, and certification of disease-free seed-crops gives further protection. Both have their limitations, especially in dealing with pests that are not readily recognized, and both fail against many soil-borne and all air-borne diseases—and insects—that infect the plant rather than the seed. Horticultural crops can be protected with fungicides and insecticides, but these as a rule cannot profitably be applied to field crops with their larger area and lower value per acre. The production of immune or resistant varieties is the most effective defence, and also the most economical because the first cost is the last cost. Once the research worker has produced an immune variety, the grower need no longer fear that particular disease; nor is he faced with costs of protective sprays.

Some notable successes have already been achieved with the introduction or breeding of resistant varieties. Introductions include club-root-resistant rape, which is giving excellent yields in areas where club-root has made the growing of rape precarious; R_1 (Stakhanovetz) linen flax and Cheyenne linseed are both resistant to the New Zealand strains of flax rust; Achilles oats, an Algerian type, is resistant to leaf-rust and stem-rust; and Calder swede, produced at the Agronomy Division, is strongly resistant to aphis attack and to turnip-mosaic, and moderately resistant to dry-rot, club-root and mottled-heart.

During the year an officer of the Plant Diseases Division has been stationed at Lincoln with the Agronomy Division. A glasshouse unit, specially designed for disease work, has been erected by the Agronomy Division staff. Major projects commenced include breeding for resistance to wilt of peas, rust of flax, mildew of wheat, stem-rust and leaf-rust of oats, and club-root and aphis of Brassica crops. Work on resistance to blight and virus diseases in potatoes can now be increased with the impending completion of the potato greenhouses. Other crops—especially the main vegetable crops—will be included as soon as possible.

RESEARCH ON FIELD CROPS

Oats.—Lodging in oats is a serious defect of the chief milling varieties, especially under the high-rainfall conditions in Southland, where they are principally grown. An older breeding project in which Resistance was used in combination with New Zealand standard varieties has not proved succeesful. More recently S. 172, a specially short and stiff-strawed oat from the Welsh Plant Breeding Station at Aberystwyth, has been used as the lodging-resistant parent. In future, selection will be carried out both at Lincoln and in Southland.

Breeding for resistance to the oat rusts, which frequently cause considerable damage to oat crops over wide areas, has been intensified.

Barley.—The barley experiments were transferred from Lincoln to a leased area at Ellesmere, where conditions are more typical of the barley-growing areas. Work on the re-selection of Research barley has been continued, as has been the selection work on the hybrid material from crosses of Scandinavian and English barleys.

Rape.—The demand for club-root-resistant rape has continued to increase. A higher-yielding, earlier-maturing club-root-resistant strain is the objective of a selection programme in the cross, club-root-resistant × Broad Leaf Essex. Twenty-three plants of the desired type were selected from a heavily club-root-infected area at Winton. This strain is not yet fixed either for type or for resistance.

From a cross between club-root-resistant rape and aphis-resistant swede, 2 out of 78 plants survived a heavy aphis attack, and they will be used to build up a rape that is resistant to aphis as well as club-root.

Kale.—The hybrid between giant chou moellier and thousand-headed kale again performed creditably in trials at Gore and Lincoln, giving a higher leaf-yield than either parent, and a stem-yield comparable with that of giant chou moellier. A population derived from the crossing of leafy chou moelliers gave a high leaf-yield and good total yield in both localities. Both these hybrids have also shown great promise in observational trials; the results of the Department of Agriculture trials this season will finally decide which of them will be distributed to farmers.

Swedes.—The cross Calder × Danish Giant shows promise of high yield and tolerance of dry conditions.

The mechanism of field resistance to aphids exhibited by Calder and Sensation is being investigated. Aphids reproduce more slowly on resistant varieties, which, however, succumb if the initial infection is abnormally heavy.

Potatoes.—The glasshouses for potato research at Lincoln are nearing completion. They will be used for the production of virus-free seed of standard varieties and for the breeding of new varieties immune from, or at least resistant to, blight (*Phytophthora infestans*) and virus disease.

Several potato varieties imported from Scotland and from the U.S.A. have remained free from late blight in trials at Pukekohe when standard varieties alongside were quickly killed by this disease. Their yield and quality are very promising.

Dormancy-inducing hormones applied to tubers were highly successful in retarding sprouting, but are still rather expensive for general application.

2, 4, 5-trichlorophenoxyacetic acid applied to the foliage during flowering induced dormancy in the tubers, but when strong enough to have any worthwhile effect also reduced yield and had a deleterious effect upon tuber shape.

Linen Flax.—A rust-immune strain of Liral Crown is to be built up from crosses that have been made between the present susceptible strain and tested immune selections from the Russian and Argentine varieties. This will give an alternative to fall back on in case the Russian selection should prove disappointing in fibre-production.

Linseed.—Golden Viking gives an excellent yield of high-quality oil, but deteriorates rather rapidly in a wet harvest, is a little late maturing for some districts, is susceptible to pasmo, and has recently proved susceptible to one race of rust. Cheyenne is an early-maturing variety producing good-quality seed, but its yield is not as high as that of the later varieties. It is immune to rust, and fairly tolerant of pasmo. Rio is a late-maturing variety, highly resistant to rust, browning, and wilt. It is, however, rather susceptible to pasmo, and has not yielded very well in trials. These three varieties are being combined in a triple cross, with the object of producing an early-maturing, high-yielding variety, resistant to rust, browning, wilt, and pasmo, that will withstand bad harvest conditions.

Lupins.—Much lupin-seed is lost at harvest through shattering. A non-shattering selection of sweet yellow lupin with white seed is now being increased as rapidly as possible.

The sweet white-flowered lupin has been crossed with the bitter pink to incorporate in the former the early vigour and soft seed-coat of the latter.

Peas.—A Greenfeast pea has been developed that is resistant to pea-mosaic. This will go into field trials next season.

Pea-wilt (*Fusarium orthoceras*) causes serious losses in some districts; breeding for resistance to this disease is in progress, using resistant parents from America in crosses with New Zealand varieties of field and garden peas.

Work is being continued on the production of: (*a*) a pea as early as William Massey, but with a better yield; (*b*) a higher-yielding, earlier, Blue Prussian; and (*c*) a smooth-seeded, early, evenly-maturing Partridge. None of the previous attempts to achieve this has been successful. Indeed, the dimpled character seemed to be so closely linked with the Partridge-type seed-coat that they appeared to be inseparable. However, the desired combination has now been produced in a cross between Partridge and Black-eyed Susan, and selections will shortly be tested for yield.

Lucerne.—Work is in progress to improve still further the performance of New Zealand certified lucerne, which was bred by the Agronomy Division and tested under the name "Strain B."

There is widespread interest in the possibility of producing a lucerne that will stand up to hard grazing. The most promising variety—*Medicago glutinosa*—will probably stand hard grazing, but gives rather a low yield of forage and a very low yield of seed. Crosses have been made between New Zealand certified lucerne and *M. glutinosa* in an attempt to combine the desirable characters of both parents.

New introductions of creeping lucernes from Canada are under test, and it is hoped that some of these may prove more satisfactory than those already tried.

RESEARCH ON VEGETABLE CROPS

Survey of Varieties.—A great range of varieties and strains of vegetables has been examined over the past three years for varietal purity and suitability for New Zealand conditions. This range of material has been obtained both from overseas and New Zealand sources, and has consisted mainly of strains and varieties of broccoli (winter cauliflower), savoy, summer cabbage, spring cabbage, cauliflower, beans, lettuce, carrot, tomatoes, and sweet corn, as well as other subsidiary crops. The total number grown and examined of samples of commercial seed is approximately 1,800.

This survey has shown that there is great variation of type within strains and varieties of commercial seed, especially among the Brassicas, and that some considerable improvement can be effected by careful selection.

Selection.—Selections have been made from promising lines of savoy cabbage, spring cabbage, broccoli (winter cauliflower), summer cabbage, and Holmes Improved carrot. Even in one or two generations of selection, a very marked improvement has been made in the uniformity and type of the stocks concerned. The first of these selections are now ready for increase and distribution.

Breeding.—Work on the hybrid onion-seed project has commenced, and so far the work is concerned mainly with the introduction of the male-sterility factor into the variety Pukekohe. Once this has been accomplished it will be possible to produce hybrid onion-seed by using male-sterile Pukekohe as one of the parents.

Breeding-work has also commenced in the dwarf beans with a view to obtaining an early-maturing variety resistant to a condition called "Yellows."

Crosses have been carried out among several varieties of tomato in order to find parents suitable for the production of hybrid lines.

Seed-production.—The early winter cauliflower (or broccoli) fills a gap between the autumn and the late-winter cauliflower. Seed-production in this important group of varieties presents special difficulties, and this in fact is the cause for the small number of varieties and the scarcity of seed of this type. It cannot be produced in England, and has not previously been raised in New Zealand. The difficulty of seeding is due to the fact that the curds are exposed to the severe weather conditions of late winter before running up to flower, and are frequently killed. It is therefore necessary that these varieties should be grown and seeded in a comparatively frost-free area that is not too humid. New varieties, maturing in early winter, have been introduced into New Zealand, and trials in seed-production have been carried out at Governor's Bay, where good yields of seed have been obtained.

Hybrid sweet corn has been produced from inbred lines obtained from America.

Irrigation.—Irrigation experiments have shown that there is a considerable improvement in the quality as well as the yield of most vegetables when grown with overhead irrigation. The results of last year's experiments have been published, and those for this year are being prepared for publication.

PLANT BIOCHEMISTRY

Potatoes provide a large proportion of the vitamin C in the human dietary, and this factor in the diet becomes very important during the late winter when natural sources of the vitamin are lowest. The recently established chemical laboratory, in charge of an officer of the Plant Chemistry Laboratory, is engaged in the evaluation of different varieties in respect of vitamin C, and in measuring the degree to which different varieties retain the vitamin during long storage periods. Preliminary work has shown considerable differences in the behaviour of some varieties. A sprout-inhibiting dust, and one preventing rot, had no effect on the vitamin C retention of two well-known varieties.

Other work is in progress on the biochemical factors involved in determining aphis attack on swede varieties, biochemical differences affecting the feeding value of chou-moellier varieties, and the development of more reliable methods for the determination of sugars and other carbohydrates in plant tissue.

SUBSTATIONS

Arrangements have been made for the establishment and staffing of substations at Papatoetoe (vegetables and potatoes), Havelock North (vegetables and peas), and Gore (Brassica crops and oats).

The report on the Grasslands substation at Lincoln appears under Grasslands Division.

ANIMAL ECOLOGY SECTION

Officer in Charge: Dr. K. Wodzicki

The programme of work approved by the Animal Ecology Research Committee consists of two major investigations: a study of the biology of the rabbit, and a survey of the mammal and bird fauna of New Zealand. Of these, the work on bionomics of the rabbit has priority. The detailed research programme includes studies on the reproduction, feeding habits, population dynamics, behaviour, parasites, and diseases of rabbits and the effects of rabbits on the composition of pasture. The purpose of this investigation is to provide basic information on the biology of the rabbit as a factual basis for improved control measures.

After an inspection of several areas, Gwavas State Forest in Hawke's Bay was selected as the most suitable site for this work. Owing to the shortage of various materials, considerable delay occurred in the fencing of the experimental area and the purchase of essential equipment, transport, and accommodation for research personnel. These difficulties have now been largely overcome, and with the arrival of an experienced ecologist from England research work has now commenced.

Work on methods of assessing rabbit populations was continued, and a preliminary study of the parasites of the rabbit is nearing completion.

A general survey describing the distribution, status, and economic importance of the twenty-eight feral introduced mammals of New Zealand is being published as a departmental bulletin. The gaps in our knowledge revealed by this report are gradually being rectified by local surveys when opportunity offers.

Detailed local surveys of the fauna of Fiordland, White Island, the western shore of Lake Taupo, and of other areas have been completed, and the preliminary results have been made available to various bodies interested in wild-life research or control. Further surveys of bird damage in Wairarapa and Nelson orchards have been carried out, and further blackbird material has been collected and preserved for a study of the ecological status of this species in orchard areas. Although the value of such surveys cannot be expressed in terms of money and this work is necessarily limited by other commitments, there is need for extension of general and local surveys, which are essential for planning the preservation of native species and the control of introduced ones.

APPLIED MATHEMATICS LABORATORY

Officer in Charge: Mr. I. D. Dick

During the year it became increasingly clear that the statistical activities of the Biometrics Section were being extended beyond the fields of agriculture and biology, and increasing attention was being given to statistical problems arising in other sciences, particularly geophysics. Because of this development it was felt that the former designation of Biometrics Section was not sufficiently wide to cover its work, and the branch was renamed the Applied Mathematics Laboratory. This Laboratory was also instructed to plan facilities for work in mathematical physics, as well as mathematical statistics and large-scale computations.

Projects.—Theoretical work necessary for the design of a sampling system for estimating agricultural and pastoral statistics. This project was requested by the Government Statistician.

The results of experiments over eighteen years on apple-trees are being analysed. Such variables as fruit yields, weight of prunings, height and girth of trees, &c., are being included in the analysis.

Some time ago the New Zealand Standards Institute made measurements on each foot of five thousand children ranging in age from two to fifteen years. These data have been analysed for the Institute and results will be written up shortly.

As part of his thesis for a Ph.D. degree, Dr. R. M. Williams investigated some of the theoretical aspects of systematically designed experiments. The results relate chiefly to experiments laid out in long rows or occurring sequentially as in some industrial processes. This thesis is now being rewritten in a form more suitable for publication in a scientific journal.

The study of time series has been progressing satisfactorily. Correlograms and periodograms for atmospheric pressure, horizontal magnetic intensity, and wave records have been made. In the immediate future this work will probably be applied mainly to oceanographic records.

Work on the distribution of bacteriological and entomological phenomena is proceeding favourably and the theoretical results will be shortly tested by sampling experiments.

The methods developed by Mather to place quantitative inheritance problems on a firm theoretical basis are being studied with a view to estimating their possible value in solving local problems in animal and plant breeding.

Staff Training.—An officer is being trained to provide statistical services for departmental institutions in the Palmerston North district. He will commence duties there late this year. An officer was also trained for the New Zealand Forest Service. It is also highly satisfactory to note that the first of the officers trained overseas has now returned to duty in New Zealand.

Computational Work.—The first instalment of the punched-card equipment has been operating most satisfactorily for about nine months, and has proved itself a most valuable acquisition.

AUCKLAND INDUSTRIAL DEVELOPMENT LABORATORIES

Director: Mr. J. B. Brooke

The most significant feature of this fifth year of service is perhaps the growing appreciation of the importance of science to Auckland's expanding industry. The year has been one of consolidation, the final establishment of the Laboratories having been effected, and the position with regard to staff and equipment has been very satisfactory. With the recent arrival of a senior metallurgist from England, this section of the Laboratories' industrial service is being developed.

Several major projects have been completed and installed under normal working conditions with very gratifying results. The newspaper-wrapping machine has been in continuous operation in the publishing office of a provincial daily newspaper for the greater part of the year, and it has been found possible to increase its speed of operation from 2,500 to 3,000, and (more recently) to 3,800 papers per hour. Patents have been arranged to protect the novel features of this machine, which has attracted considerable interest in overseas publishing circles. The automatic machine for making artists' brushes is also

in commercial use, and is giving most satisfactory production. Modifications have been added to permit the use of latex for setting the tuft, and to allow the larger tempera brush for school use to be produced.

Further development work on the cardiotachometer, or pulse-rate recorder, has eliminated most of the interference that was found to occur on the operating-table, and this equipment is now available as a further research tool in modern anæsthesia. Less success was attained with the portable artificial breathing equipment, also made for hospital use. Failure of a small driving motor in the oxygen-enriched atmosphere of the apparatus has made a major redesign advisable to allow of manual operation in the event of electrical failure.

Other items of particular interest during the past year are mentioned under Section headings, but only brief reference can be made to the large number of unspectacular small projects that constitute the major portion of the day-to-day work of the Laboratories.

PHYSICS SECTION

Little change in the work carried out by the Physics Section has taken place during the year. With an increase in staff it has been possible to put the Metrology Section on a reasonably sound basis and to undertake check calibration of the equipment in use.

Additional instruments have arrived from overseas, widening the scope of work and making more efficient that already handled. Among these is a 16-point electronic recorder, which has been most useful in making continuous temperature records at various points in a sterilizing autoclave, and recording temperatures in the glasshouse investigation.

Blood Cells.—A prototype short path flow cell for use in a spectrophotometer has been made, and is now under test at the Auckland Hospital. This cell enables a film of blood 0·0015 in. thick to be examined, and careful design has simplified the production of such a cell, which must be capable of being filled without exposing blood to the oxygen of the atmosphere at any stage.

Dust Sampling.—Equipment has been built for collecting and examining samples of industrial and other dusts. Experiments have been made to develop satisfactory methods of sampling and evaluating results. It is hoped to be able to determine the quantity of dust per unit volume and also the sizes and numerical distribution of the particles present.

General.—As in previous years, the major portion of the work has been divided between testing and calibrating a wide range of measuring equipment and the repair and adjustment of numerous optical and other scientific instruments. It is hoped that industry will gradually take over this class of work and so leave the laboratory free for investigational and development work.

ELECTRICAL SECTION

The Electrical Standardization Laboratory has now been set up, and an intercomparison with the Dominion Physical Laboratory will shortly be undertaken to establish the order of accuracy obtainable. The purpose of the equipment is to provide an economical and accurate calibration service for electrical indicating instruments in the ranges normally encountered in industrial work.

The pulse-rate recorder has been further developed, and a redesign of the amplifiers has resulted in a greatly improved performance. It is believed that development has proceeded as far as possible, and it is proposed to build the equipment as a compact and self-contained unit.

A precision chronograph has been developed for measuring short time intervals. This equipment is to be used initially for the determination of bullet velocities by measuring the time of flight over a range of 180 ft. The accuracy of the equipment is designed to be 0·005 per cent. ± 10 microseconds with a

maximum range of 1 second. The unit consists of: (*a*) a precision oscillator running at 100 kc./sec.; (*b*) a precision electronic gating circuit controlling the output of the oscillator; (*c*) an electronic counter capable of counting precisely the number of cycles at 100 kc./sec. that are passed by the gate during the interval to be measured. Special precautions are taken to ensure minimum errors due to switching times, &c.

A wide range of demonstration equipment has been designed for use at the Seddon Memorial Technical College in connection with an industrial electronics course which has been started this year. Maximum use has been made of the principal of visual education by making the demonstration boards large and legible. The lecturing is being done by a member of A.I.D.L. staff, who finds this method of teaching most successful.

Micro-flash equipment has been built which makes possible the taking of photographs with an exposure time of less than 5 microseconds. Some very useful photographs have been made of very high-speed mechanical movements with its aid.

A Photographic Section has been established during the last year, and a wide range of work is being done in the recording of progress of development jobs, macro-photography, photomicrography, high-speed flash photography, and the duplicating of technical data.

An electronic control device has been developed for automatically feeding a card-blanking press. The card is positioned by a photo-cell operating from an index mark on the card, and the movements of the machine are subsequently controlled by relays and solenoids.

ENGINEERING DESIGN SECTION

In addition to the development work already mentioned, the following projects are of general interest:—

An experimental water-sampling device has been developed for obtaining samples from thermal bores in the Rotorua and Wairakei areas. Designed to operate at depths up to 500 ft., this sampler brings approximately 100 c.c. of water to the surface in a sealed container for analysis.

Equipment has been designed and constructed for taking underwater films. A standard 35 mm. camera of the three-lens turret type has been fitted to a special diving helmet, with suitable controls. Experimental shots have been taken with considerable success of the underwater work on the power-station intakes at Lake Waikaremoana.

Some preliminary work has been done on the dehydration of fish flesh to ascertain the drying rates under varying conditions of temperature and air velocity, and equipment has been developed to record experimental data.

Further progress has been made in the laboratory for mechanical testing of materials, this work steadily increasing in volume as equipment becomes available.

An initial approach has been made to the Cheese Mechanization Committee of the Dairy Research Institute, and it is hoped that considerable assistance can be given to the Committee during the coming year, particularly in the development and construction of prototype equipment.

WORKSHOP SECTION

Besides undertaking the constructional side of work for the Design Section, such as the newspaper-wrapping machine, the underwater camera, &c., this Section continues to handle special machining processes for local industry, particularly in the engraving and form relieving section. Working from photo-engraved masters, biscuit-forming dies and moulds for plastic embossing have

been produced. The relieving lathe recently installed has been used to produce embossing rolls having a wave profile engraved in multiple on their surfaces. Some experimental work has been carried out on self-cooling of grinding-wheels, using a coolant drip to a hollow wheel arbor. The coolant is delivered through the open grain of the wheel direct to the work surface by centrifugal force. This will allow of a much heavier cut being taken on a normal dry grinding-machine, without damage to the work piece or the wheel.

BOTANY DIVISION

Director: Mr. A. L. Poole

One member of the staff is studying plant sociological methods in Europe, one is studying plant introduction in Australia, and one is studying cytology at the John Innes Institute of Horticulture, London. The Goldsmith Scholarship holder from the London University, who has been studying *Nothofagus* forests, is nearing the end of her term and will be returning to England.

HERBARIUM

The importance of the herbarium is continually increasing as it is the centre of much of the Division's work, including taxonomic research, the revision of Cheeseman's "Manual of the New Zealand Flora" by Dr. H. H. Allan, and the production of smaller floras on grasses, naturalized plants, and water-plants. It is also used for the accurate identification of plant introductions, and for the extensive identification service undertaken for other Government Departments and outside organizations. Some 3,000 specimens were identified for bodies within New Zealand and nearly 10,000 were dried and identified for overseas visitors to the Pacific Science Congress.

The staff made about 5,000 additions to the Herbarium, bringing the total close to 70,000 sheets. Localities specially collected from included Great Barrier Island, North Auckland—water plants only—and parts of the South Island. The seaweed and seed herbaria have been increased, 388 packets of seed being added to the latter. Seeds and fruits of water-plants, important in the study of wild-duck foods, are now well covered.

A new technique for the drying of specimens reduces drying-time to almost one-quarter of that taken previously, and produces specimens in a better state of preservation.

TAXONOMIC BOTANY

In taxonomic studies work has commenced on the genus *Hebe*; in the genus *Agropyron* a number of true-breeding self-fertile forms have been distinguished and their distribution in the field studied; an artificial hybrid with pronounced heterosis, between one of these forms and *A. kirkii*, has been obtained; the study of water-plants, which have not been worked on critically for many years, has increased, and many taxonomic problems are being encountered; the flowers and fruits of New Zealand *Nothofagus* species have been described in detail.

ECOLOGY

Tussock Grasslands.—At Molesworth and part of the St. Helens Run, work has continued. Broad mapping and detailed analyses of the principal vegetation units were commenced during the year, and from this a technique for studying extensive tracts of tussock grassland should be developed. In many sowings between tussocks and in bare places tall oat-grass (*Arrhenatherum elatius*) is the only species that has established permanently. Sets of photographs—taken in

February, 1944, February, 1947, and March, 1950—show that there has been no appreciable increase in the area occupied by native tussocks. Six years' observations at Molesworth demonstrate clearly that here tussock once lost does not regenerate freely even under reduced grazing. This emphasizes the importance of doing everything possible to preserve all remaining areas of tussock in this type of country.

The different strains of *A. scrabrum* are being studied in various tussock areas with a view to selecting suitable ones for more extended use.

Experimental sowings were extended to a part of the Fruit Research Substation at Earnscleugh.

Beech.—Regeneration following the 1949 seeding has been examined in several parts of New Zealand, and records obtained from a number of observers. It appears that regeneration does not necessarily follow heavy flowering, as the weather at this time may affect the subsequent development of seed. In one forest the 1950 fall of seed was measured and proved to be approximately 1 per cent. of the 1949 fall in numbers of seed.

Fiordlands.—An account of the vegetation of the area covered by the Fiordland Expedition and of the effect of the deer population in this area is complete.

Surveys.—Maps showing different features of the vegetation of the Ruahine Mountains have been completed.

PEATS AND POLLEN INVESTIGATIONS

Hay-fever and Honey.—Honey samples showing peculiar characters have been examined from time to time for their pollen content.

Atmospheric pollen surveys in connection with hay-fever have been carried out at Wellington, Napier, Rotorua, Hamilton, and Auckland, and reports supplied to medical officers concerned at these places.

Ecology and Peat Classification.—Vegetation surveys in swamps and lakes of the Auckland Province have been carried out in connection with a study undertaken by the Marine Department for the stocking of the lakes. Further reconnaissance work of peat areas in Canterbury and Westland was undertaken.

Pollen Analysis, Peats and Lignites.—Pollens from Wanganui lignites provide additional evidence, and support geological findings, that these beds are younger than was previously supposed.

ECONOMIC BOTANY

Plant Introduction.—The plant introduction service has expanded rapidly, and 620 introductions—of which 249 were handled by the Division staff—were recorded in the Central Register. A seed list for overseas exchange was compiled and circulated, and the response showed a keen interest in New Zealand crops seeds by research institutions.

Peat Survey.—The peat areas adjacent to Paraparaumu were surveyed at the request of the District Planning Officer, and the results have proved useful in the land-utilization planning of this difficult area.

Washdyke Lagoon.—In connection with the use of this lagoon and its surrounds for game, a report has been made of the vegetation, more particularly the water-plants.

Forest Dendrology.—Study has been confined mainly to *Pinus radiata* in the Nelson region, and attention has been paid to the development of seedlings and trees up to four years old, with special regard to the origin and growth of lateral shoots. A preliminary progeny trial has been commenced.

Seaweeds.—For the first time supplies of seaweed were insufficient to keep the agar-factory fully employed throughout the year. Quantities had fallen particularly in Bay of Plenty and North Auckland, and in the former district some evidence was found of depletion of inshore beds. Supplies from all districts are improving in autumn, 1950. As a result of investigations made in Australia last year some weed of *Gracilaria* has been imported from New South Wales and it has been found possible to supplement local weed with a small proportion of this without lowering the grade of the finished product.

Phormium.—At the Moutoa Phormium Research Station intensified investigations on yellow-leaf disease are continuing. An outbreak of the disease with severe wilting and a high incidence rate occurred in the variety Ngaro in one trial area; by contrast, the variety SS in the same trial has shown marked resistance. Nevertheless, in an SS plantation established in 1940 the disease was found to occur more frequently than usual in this variety but is not sufficiently serious to alter the recommendations made for its extensive propagation. An inspection of phormium areas in the Invercargill and west coast districts of the South Island has shown that the disease is present, though it does not threaten commercial production.

A very sparse flowering has limited the amount of breeding-work, and also the possibility of producing SS seedlings for commercial planting on the Moutoa Estate. Work on improving the methods of raising plants from seed has been continued.

A map covering a resurvey of the vegetation on the eastern half of the Moutoa Estate shows the detrimental effects to natural phormium stands brought about by over-drainage and prevention of flooding. Permanent quadrats for detailed study have been laid down in some of these stands.

Seed which normally lose viability quickly, when stored in airtight conditions for two and a half years had a germination of 79 per cent.

MISCELLANEOUS

New Zealand and American Fiordland Expedition.—The Director has completed the final report, consisting of the combined accounts of all parties invited to participate in the Expedition.

Artist.—The Division's artist prepared illustrations for several publications, including an educational bulletin on sand-dune plants, articles on mosses, lichens, water-plants, seaweeds, and *Nothofagus*. An index to all drawings has been made.

Publications.—During the year eleven technical and three popular publications were prepared by members of the staff.

DOMINION LABORATORY

Director: Mr. F. J. T. Grigg

The year has shown a steady growth of the Dominion Laboratory, both in Wellington and in the district laboratories at Auckland, Christchurch, and Dunedin. Staffing has improved, although there is still a serious shortage of that group of chemists between the most senior and the most junior grades, and certain categories of scientific work are still restricted by the insufficient recruitment to the laboratories of the best science graduates. To compensate for the low replacement rate of the war years there has been a rapid over-all increase of staff to meet the increasing demands for chemical investigations, and this has given rise to a shortage of space. Apart from a very few minor temporary additions, the Wellington buildings are very much as they were ten years ago when the staff was only half the size that it is now. Although, unfortunately,

this difficulty appears to be common to most Government Departments, shortage of working space undoubtedly hampers efficiency and at present shows little prospect of being satisfactorily relieved.

The work of the Dominion Laboratory includes service work and day-to-day chemical and chemical-engineering problems. In addition, however, much fundamental investigational work is carried out, and the complexity of modern conditions makes such work increasingly necessary and important.

The following table shows the number of samples received during 1949 by the Dominion Laboratory, Wellington, and its district laboratories.

Contributor or Department.	Wellington.	Auckland.	Christchurch.	Dunedin.
Agriculture	122	..	182	128
Air	110	10	..	..
Army	22	1	..	..
Broadcasting	3	..	3	..
Customs	143	27	6	21
Education	6	..	1	..
Food Controller	..	64	3	..
Forest Service	579	44	1	2
Health	5,240	6,692	5,253	2,913
Housing	220	41	1	2
Hydro-electric	60	2	2	..
Industries and Commerce	69	4	..	3
Internal Affairs	12	..	..	..
Island Territories	1	..	..	..
Labour	9	4	..	16
Land and Income Tax	..	..	..	1
Lands and Survey	..	1	3	..
Local bodies	47	196	775	33
Main Highways Board	76	..	..	..
Maori Affairs	14	..	..	..
Marine	7	1	..	27
Marketing	28	377	9	35
Mines	1,301	..	..	1
Navy	12	10	..	..
Plunket Society	191	117	97	65
Police	184	247	201	49
Post and Telegraph	147	10	6	..
Pottery and Ceramics Research Association	46	..	..	..
Printer	5	..	..	..
Prisons	204	..	..	..
Public Trust	..	1	..	..
Railways	28	15	8	5
Scientific and Industrial Research	..	..	212	..
Information	100	..	..	..
A.I.D.L.	17	18	..	..
Dominion Laboratory	190	12	2	32
Fats Research	1	..	..	..
Physical Laboratory	189	..	..	..
Geological Survey	79	..	2	6
Plant Diseases	94	1,892	..	..
Plant Chemistry	2	..	..	..
Soil Bureau	7	..	..	..
Industrial	490	..	..	63
Standards Institute	16	..	..	..
State Advances	95	132	9	2
Stores Control Board	11	..	..	1
Tourist	1	..	..	..
Works	307	24	18	15
Miscellaneous	321	2	15	25
Total	10,806	9,944	6,809	3,445

The samples received are an indication of the amount of service work carried out. The number received during 1949 (31,004) was slightly less than in 1948 (31,677). The work done for the Department of Health decreased by about 2,000 samples, mainly milk samples in the two South Island districts.

In addition a great deal of time was spent by professional officers in answering chemical and chemical-engineering inquiries, in serving on technical committees, and assisting other Departments with professional advice on their problems.

DISTRICT LABORATORIES

The work of the district laboratories is not shown separately, but is included under the subject headings; they have continued to provide services dealing mainly with foods, drugs, toxicology, gas-testing, analyses, general advisory work, industrial investigations, &c. Each of these laboratories is under the charge of a Government Analyst, and has a staff of four to six chemists and the necessary non-professional staff, which includes four or five technicians.

ROCKS, MINERALS, AND CLAYS

Practically all of this work is concentrated in the Wellington Laboratory. It comprises analyses and investigations of silicate and other minerals for the Geological Survey, Soil Bureau, Pottery and Ceramics Research Association, and Mines and various other Government Departments. In the absence of a section of the Laboratory to deal specifically with building-materials, problems of cement, concrete, concrete aggregates, and concrete products were handled in conjunction with the rock and mineral work.

A senior officer returned towards the end of the year from a course of study in radio-chemistry lasting fourteen months, during which he visited institutions in the United States of America, Canada, and England. Training was obtained in the techniques used for the handling of isotopes, both radioactive and stable, for use in medical and biochemical problems. The information and experience gained will be of the greatest assistance in the research on these matters which will be carried out in New Zealand.

Analyses were made of titanomagnetites separated magnetically by the Dominion Physical Laboratory from North Island black sands. The residues were also further fractionated magnetically in a search for ilmenite. A well-equipped laboratory was set up at Onekaka to carry out urgent analyses for the iron-smelting experiments that were made by the Department of Industries and Commerce. Both at Onekaka and at Wellington numerous urgent analyses of sinters and slags were made in connection with the experiments.

An investigation was made of materials collected by the Geological Survey from Oamaru, Canterbury, Te Kuiti, and other districts in relation to their use in the manufacture of cement.

For the Ministry of Works further investigations were made of rock materials suggested for use as aggregates in concrete for hydro-electric dams on the Waikato River. The chemical method was again used for attempting to evaluate the potential reactivity of rock aggregates with high-alkali cement which may lead to deterioration of concrete, and this method was supplemented by Stanton mortar-bar tests in which the expansion of bars of concrete made under prescribed conditions and stored in closed containers over water in a constant-temperature room is measured from time to time. While the

Stanton test has the disadvantage that it takes up to two years to complete, it will give a more direct and, therefore, probably truer indication of the reactivity of aggregates with cements than is possible with the quick but possibly unreliable chemical test.

Commenced in 1945 at the request of the Ministry of Works, an extensive investigation into the extent of the deterioration of the concrete of the Manorburn irrigation dam was completed and a final report made. The causes of the deterioration appear to have been satisfactorily established, and can be provided against in future dams.

Examination of concrete pipes from the Hutt Valley suspected to have been damaged by corrosive ground water showed that the damage was less than had been supposed and was largely due to faulty manufacture of some of the pipes.

Investigation of the deposits of volcanic materials of possible value as pozzolanas for the making of improved Portland cements was carried a stage further with the completion of determinations of lime-reaction rates and solubilities in alkali on selected samples. Materials from the Oamaru and Gisborne districts were shown to be promising. The results obtained require confirmation by strength tests, for which a standard vibration machine is expected to arrive shortly. In the meantime, as an aid in the evaluation of pozzolanic materials, methods of determining free lime in hardened cement mortars are being studied.

In addition to the routine examination of many concrete and clay roofing-tiles for compliance with specifications, assistance was given to manufacturers in overcoming manufacturing difficulties. Curves showing the grading of the aggregate are drawn for all concrete tiles tested, and it is possible to assist manufacturers in improving their product where the grading of the aggregate is faulty.

FOOD, DRUGS, AND WATER

Milk-supplies in the Wellington Province were found to be reasonably satisfactory. Of 4,500 samples, 50 contained added water, 30 were deficient in fat, 13 were insufficiently pasteurized, and a small number were stale. These figures do not give quite a true picture, as supplies found to be at fault are usually sampled repeatedly, and the figures therefore include rather an undue number of faulty samples.

Auckland district milk-supplies showed no marked improvement during the year.

In Canterbury the most striking points about the milk-supplies were the substantial increase in the number of milk samples found to contain added water and the continued fall in the percentage of milk solids other than milk-fat, which has now reached the low average figure of 8·72. Over 300 samples of milk contained less than the legal minimum percentage of milk solids other than milk-fat.

The general trend of improvement in the Dunedin milk-supplies continued. The proportion of improperly pasteurized milk fell very sharply, but is still too high. About 8 per cent. of raw milk sold in Dunedin City was found to be stale, which is a slight improvement on the previous year. The number of milks low in solids other than fat has, however, increased.

Many other kinds of food were examined in the four centres, of which the following examples are typical:—

Saccharin (undeclared) was found in two syrups.

Excessive amounts of sulphur dioxide were present in many samples of sausages and minced meat.

Bacon, especially in the Auckland district, frequently contained boric acid, in contravention of the regulations.

Dirt and foreign substances were found in bread, flour, sugar, sausages, and other foods. Some of the materials found were dangerous, while others were merely disgusting. All such instances were evidence of a lack of care in the handling of food, which appears to be increasing. Some successful prosecutions were taken by the Department of Health and may help to draw attention to the need for greater care.

Zinc was several times detected in gin imported in galvanized-iron drums.

Molten tin used for tinning food utensils tends to become contaminated with lead derived from solder. In a few instances more than 2 per cent. of lead was found, but the situation was better than in the preceding year.

About a quarter of the samples of iodized salt examined were somewhat deficient in iodine. The permission to add a small amount of a harmless stabilizer, as is allowed in some other countries, appears to be worth consideration.

Several carbonated beverages contained salicylic acid, the use of which as a preservative is now prohibited.

A variety of foods contained artificial colouring substances without the requisite declaration of their presence being given in the label.

A survey of butchers' shops made by the Department of Health disclosed a number of meat-pickling preparations that contained dangerous substances not fully labelled as required by regulations.

A considerable proportion of the cream samples examined, particularly in Christchurch, were deficient in fat.

Milk-shakes, in many cases, contained less than 3 per cent. (the legal minimum) of milk-fat, and frequently contained living coliform bacilli.

Enamelled trays made for use as drip trays in refrigerators were being sold to the public and used in the preparation of food. It was found that these trays were not resistant to acid—as required by the regulations.

The swelling of cans of tongues was found to be due to the decomposition of excess of nitrite added during canning.

Arsenic was found in oyster products in much higher amounts than is permitted by the regulations. As it was already known that arsenic occurred naturally in certain marine animals, including oysters, and as it is known that it exists in a form less toxic than the ordinary inorganic forms of arsenic, further investigation seems warranted. The position is complicated by the fact that analyses of tinplate used for food cans showed that the surface was not free from arsenic and that undesirable amounts of arsenic in its inorganic forms might be taken up by the canned food.

Many analyses and bacteriological examinations of waters were made, including a survey of the main water-supplies for traces of fluorine. The amount of fluorine present was in no case sufficient to have an adverse effect on health.

Drugs sampled showed that the requirements of the British Pharmacopœia, the British Pharmaceutical Codex, and the New Zealand Formulary are generally complied with. The saponification value of a coconut-oil did not come within the official range, but values recorded in recent literature indicate that the specified range may now be out of date. Medicines dispensed by pharmacies to doctors' prescriptions were analysed, and some of the medicines found to be not as ordered.

MEAT RESEARCH

The increasing demand for meat of better quality has led to an agreement between the United Kingdom, Australia, and New Zealand for collaborative research into better methods of freezing storage, and transport of beef. Very little research on this subject had been done except for a comprehensive survey of the industry made in 1932.

The Dominion Laboratory assisted in carrying out a practical trial of a new system by which lamb carcasses and offals were shipped to England in wraps of a plastic material according to the "Cry-O-Vac" process. The purpose was to determine whether shipment in bags impermeable to water vapour would restrict weight losses from the meat, preserve the natural bloom, and prevent "streak" on the surface after thawing, and whether the particular bags used were sufficiently strong to withstand the handling during processing and transport. Some improvement in the appearance of the carcasses and offals resulted from the use of the bags, but the slippery nature of the bags led to handling difficulties on the ship.

An officer of the Laboratory spent a month at the Division of Food Preservation and Transport, Homebush, Sydney, and the Cannon Hill Meat Laboratory, Brisbane, discussing research problems and organization with Australian workers in meat research.

ORGANIC CHEMISTRY

In co-operation with the New Zealand Forest Service the study of the New-Zealand-grown pines, *Pinus radiata, P. laricio,* and *P. murrayana,* was continued. The determination of the distribution of resinous extractives in *P. radiata* was concluded, and work of a similar kind on *P. laricio* and *P. murrayana* was commenced. A large soxhlet-type extractor capable of holding 100 lb. of sawdust was designed and constructed in order to obtain sufficient extracted resin for quantitative separation and analysis. For *P. radiata* the analysis was completed of the resin from heart-wood, dry zone, sap-wood, and whole wood. A similar project was commenced for *P. laricio* and *P. murrayana.* Whole-wood analyses of the three pines were also done.

Two phenolic substances, pinosylvin and pinosylvin mono-methyl ether, which have been shown by Swedish workers to have a retarding effect on the sulphite pulping of pine heart-wood, were isolated from *P. radiata.*

Work was done on the neutral-resin fraction of rimu (*Dacrydium cupressinum*) and a new compound isolated of which the structure was established as 9-keto-ferruginol. From totara (*Podocarpus totara*) a new compound, hydroxy-totarol, was isolated.

Experiments were conducted to determine the feasibility of using flax-stripper waste as a stock-food supplement. The results showed the waste to have a food value approximating to that of straw.

In response to inquiries, information was supplied on suitable adhesives for such varied purposes as gluing costume jewellery, moisture-proof cellophane, and artists' brushes. A rapid-setting dextrin composition was made for use with the newspaper-wrapping machine developed by the Auckland Industrial Development Laboratories.

TOXICOLOGY

Much toxicological work was carried out in the district laboratories and in the Wellington laboratory. As usual, many examinations were made for alcohol in stomach contents, blood, and urine. Evidence obtained in this way was frequently of use in motor-accident cases.

Poisons found in post-mortem specimens included barbiturates, nicotine sulphate, strychnine, arsenic, cyanides, lead arsenate, codeine, bromides, cresylic acid, methyl alcohol, potassium tetroxalate, and camphor.

OIL, BITUMEN, AND TAR

Analyses carried out on these products totalled 352, made up approximately by: aviation fuels, 100; petrol, 28; diesel fuels, 27; other fuels, 13; lubricating-oils, 82; greases, 6; sludges, 2; other oils and related materials, 30; bituminous materials, 18; coal-tar materials, 22; plant mixes, 12; road oils, 9; tar oil, 1; and volcanic ash, 1.

Lubrication failures and allied problems were investigated. One of the most important of these related to a naval vessel that was delayed by oil troubles.

Problems investigated for manufacturing industries included, among many others, the deterioration of wax used for the impregnation of drinking-straws, the identification of a special lubricant for a crankshaft-grinding machine, comparison of dry-cleaning solvents, an explosion in a degreasing plant, an explosion in a railway signal lamp, fire hazard in disinfection of aircraft cabins, and deterioration of hydraulic hoses in aircraft.

Lead susceptibilities of typical petrols marketed in New Zealand were assessed for the Transport Department.

A partial analytical service was provided for two oil companies to enable them to carry on until they could provide their own testing facilities.

PHYSICAL CHEMISTRY

Spectrographic methods were used for a variety of purposes, which included qualitative and quantitative analyses of metals, analyses of minerals, and determination of minor elements in titaniferous and magnetite sands, sulphide ores, and limestones. The carrier distillation method was used for the determination of gallium and germanium in the ash of a representative series of New Zealand coals.

An officer of the Soil Fertility Research Station, Department of Agriculture, spent four months in the Laboratory assisting in the spectrographic determination of trace elements in plant materials. The leaves of peach,

passion-fruit, orange, and pasture plants were examined with the object of detecting any relations between plant diseases and the quantities of trace elements present. Attention was drawn to the possibility of molybdenum deficiency. There was some indication that nickel might be significant.

An electrographic method for the quick identification of the metals of electrical contact points was devised for the Post and Telegraph Department.

The X-ray diffraction apparatus was found useful for the identification of crystalline components of pigments, boiler scales, and the corrosion products of metals. It was also used in an attempt to correlate the structure of different samples of plaster-of-paris with the lasting properties of the plaster moulds used for ceramic articles.

Information and advice were given on various electroplating problems and an investigation was made of the rapid pitting of pure lead by chromic-acid plating solutions. Information circulars were prepared on the plating of plastics and on porous chromium plating.

METALS AND CORROSION

Analyses were made of metals and alloys for Government Departments and for manufacturing firms. Assistance was given to the physical and engineering branches of the Department on the chemical and metallurgical aspects of industrial problems. Many problems were investigated directly for industry.

A method of cleaning type matrices was developed for a firm that was having trouble through fouling of matrices by molten type metal.

The corrosion of a launch engine manifold was concluded to be due to the action of sulphate-reducing bacteria derived from a sewage effluent.

Two failures of copper condenser tubes in sea-water were due to the fact that copper is unsuitable for this purpose.

Corrosion of deep-drawn brass articles was shown to be "stress corrosion."

Corrosion of domestic aluminium kettles was due to inclusions of silicon in the metal, although the total silicon content was within the limit of the specification.

In two cases corrosion in heat-exchangers was due to the galvanic action of copper steam pipes on the iron tanks. Such coupling of dissimilar metals appears to be all too common in New Zealand industry.

An electrical survey carried out on a heating installation in a Government building showed that corrosion experienced could not be due to stray-current electrolysis, although the potential difference between the heating pipes and nearby structures reached several volts.

A start was made on the development of methods of quantitative analysis of non-ferrous metals by the polarograph, and several routine samples were analysed by this instrument.

Many analyses were made of pig iron for the investigation of the smelting of ironsands at Onekaka.

COAL

Owing to the very large sampling programme necessitated by the coal survey undertaken on the advice of the Coal Research Committee, the staff of the Laboratory has confined its efforts largely to the making and recording of analyses of samples of coal. During the year these totalled 1,266, of which 71 per cent. were from drill-holes and were mainly supplied by the Mines Department. A further 17·5 per cent. of the samples were run-of-mine and

face samples, most of which were taken as part of the systematic survey. The large accumulation of samples from the previous year awaiting analysis was considerably reduced. A great deal of work was put into the preparation and circulation of reports and information circulars in order to make the information obtained from the surveys and analyses available as widely as possible.

Thirty-seven samples of air and other gases and a small number of miscellaneous samples from mines were analysed.

The research projects that have been suggested, and in some cases started, are largely in abeyance owing to the large volume of survey work being carried out.

CHEMICAL ENGINEERING

Plans have been made for the removal of the chemical-engineering work into temporary accommodation in a large Army store at Gracefield, where space will be available for the operation of pilot-scale plant. Considerable work was put into the drawing of plans for this Laboratory and for proposed accommodation for other sections of the Dominion Laboratory.

The workshop staff was fully occupied on jobs for the Laboratory and for other branches of the Department.

A major project in which the Laboratory assisted was the smelting of Patea ironsands at Onekaka by the Department of Industries and Commerce under the direction of overseas metallurgists. The Laboratory arranged for the assembling at Onekaka of the necessary raw materials, including ironsand, limestone, quartzite, silica sand, coke, and Waikato char. This also involved the preparation of many tons of concentrate at Patea by means of a Humphrey spiral separator. Assistance and supervision were provided in the preliminary sintering of raw materials and the final electric smelting of the ore. Subsequently a preliminary exploration was made of the ilmenite-bearing sand near Westport as a possible source of titanium-dioxide pigments or titanium metal.

Fuel-efficiency work was severely restricted by shortage of staff, but a limited amount of advisory and consultant work was done and information on fuel-efficiency matters, including steam trapping and certain aspects of corrosion, was distributed.

As the wastage of fuel in industry is still very great there is an urgent need for the passing of scientific knowledge about the burning of fuel on to the users. The problems of the use of high-sulphur coals and of changing rapidly from one type of coal to another are very acute. A thorough survey of a few steam-raising plants would well repay the cost.

Advice was given on boiler installations and on the treatment of boiler waters.

A laboratory-size plant, designed to treat 300 cubic feet per hour of coal-gas by a liquid process for the removal of sulphuretted hydrogen, is being constructed in order to determine whether this process could supplement the present method, which is a dry process using iron oxide.

The work on the curing of tobacco leaf was continued. A three-unit curing-cabinet equipped with control of ventilation, air circulation, temperature and rate of temperature rise, and with automatic recording of temperatures and indication of weight changes in the leaf, was constructed and tested. This cabinet will enable small parcels of leaves to be put through the curing process and the results of variations in curing conditions studied.

Experiments on the drying of hops showed that drying could be completed in nine hours at 120°F. The necessity for the drying to be carried out with the least possible delay was demonstrated. Plans for kilns and curing-floors for the Hop Research Station were prepared.

The experimental production of concentrated apple-juice was continued. Trials showed that the keeping-qualities of the threefold concentrate are quite satisfactory if the material is pasteurized in the bottle. Similar work on lemon-juice showed the technical possibility of concentrating it.

A laboratory vacuum evaporator with a capacity of 3 gallons per hour was constructed for the Department of Agriculture for the evaporation of aqueous extracts of pasture grasses.

For the Meteorological Office a low-pressure generator for hydrogen for filling balloons in the tropics was designed.

BUILDING-MATERIALS

Apart from the work on concrete and tiles already mentioned, building-materials investigations were confined largely to paint, of which 571 samples were received for test, and to work on the preservation of timber. Analyses were made of many kinds of paint to determine whether they complied with the appropriate standard specifications. Many samples were subjected to accelerated weathering tests.

Regular inspections were made of the five test fences and the results recorded. An attempt is being made to bring up to date all the data so far collected. Special paints were prepared for use in experiments on the painting of *Pinus radiata* timber.

The second report was prepared on the inspection of paint on State houses in Auckland in which an examination is made of the causes of premature paint failures.

In view of the numerous cases of mould growth occurring on oil paints on exterior woodwork an investigation of possible causes was undertaken in conjunction with the Plant Diseases Division. In order to determine whether the presence of "foots" in linseed-oil influenced the occurrence of mould on paints, both crude and refined linseed-oils were used, but mycological tests have not so far indicated any relationship between oil purity and mould growth.

The timber-preservation work was done entirely in the Auckland laboratory for the Plant Diseases Division, for the State Advances Corporation, and for the New Zealand Forest Service. Nearly 2,000 samples of timber were analysed, determinations being made of boric acid, zinc chloride, sodium fluoride, sodium arsenate, sodium chromate, or dinitrophenol or combinations of these constituents according to the preservative treatment to which the timber had been subjected. Work was commenced on the problem of finding a suitable quick method of determining the concentration of Wolman salts in the solutions in use at timber-treating plants. Samples of creosote were examined for the New Zealand Forest Service and the miscibility of different types of creosote with each other and with fuel oil was investigated.

GENERAL INVESTIGATIONS

Analyses were made of many samples of spraying-materials, including lead arsenates, DDT, Gammexane, Rothane, HETP, TEPP, Spergon, Thiophos, and hydrated lime. Potatoes which had been treated with DDT and with Gammexane were cooked by various methods, and the residual amounts of insecticide determined. It was found that the amounts of insecticide remaining were considerably reduced even when the potatoes were cooked in their skins.

It was found that certain samples of soda-lime that were high in silica gave very much inferior absorption of carbon dioxide when used in mine respirators than samples which were low in silica.

For the Police Department the district laboratories and several sections of the Wellington laboratory made investigations, in addition to the toxicology mentioned earlier, of which instances were: paint fragments and horse-hair in "hit-and-run" cases; clothing that had been splashed and damaged in public places by an unknown liquid was found to be contaminated with hydrochloric acid containing tin; experiments on the detection of powder traces on wax casts that had been taken from the hands of a person suspected of having fired a pistol; glass fragments found on suspected persons, which were closely similar in physical properties to those found at the scenes of crimes; samples of alleged illicit spirits and articles and apparatus alleged to have been used in illicit distillation; ashes and other materials from two cases of alleged arson; a fraudulent so-called "radioactive" fly-spray; crystals, identified from a safe that had been opened by explosives; erased markings on metal objects and on clothing that were rendered legible by chemical treatment; and social-security stamps that were shown to have been used after removal of earlier cancellation marks.

SERVICE TO INDUSTRY

A great variety of problems of a chemical, chemical-engineering and bacteriological nature were investigated for manufacturing firms. A manufacturer of orange syrup was assisted in overcoming troubles due to fermentation. A patented process of egg-preservation was investigated for the patentee and for the Department of Industries and Commerce. Difficulties encountered in the manufacture of wax matches were looked into and the cause discovered. Fish-liver oils for export were certified as to vitamin A and vitamin D content. Many analyses were made for manufacturing firms especially of metals and alloys and in connection with corrosion problems.

BACTERIOLOGY

The bacteriological examination of milks and waters, which had been carried out for some years in the Christchurch district laboratory, was extended early in the year to Dunedin, and later to Auckland. Well-qualified bacteriological chemists are now on the staffs of each of the four laboratories.

GAS-TESTING

The gas-supplies of the four main centres and of most of the other main towns were regularly examined for calorific value, pressure, and freedom from sulphuretted hydrogen. All gas-meters put into service were tested and stamped before installation at consumers' premises.

LIBRARY

A comprehensive chemical and chemical-engineering library containing about 7,000 books and receiving over 200 scientific periodicals was efficiently run by a small staff of librarians, who provided the chemical staff with all the facilities expected from a modern library. During the year a "Recordak" microfilm viewer was obtained.

DOMINION PHYSICAL LABORATORY

Director: Dr. E. R. Cooper

BUILDING RESEARCH

Thermal Insulation of Dwellings.—Work has been carried out during the winter on the saving in domestic heating resulting from the introduction of various kinds of thermal insulation into the ceilings of rooms. Savings in heating are being related to the capital costs for installation of the insulation.

Domestic Open-hearth Fires.—Work has recently commenced on the determination of the over-all thermal efficiencies of typical domestic open fireplaces and the more recent convector types, using the various kinds of domestic coals available in New Zealand to-day, with a view to the most efficient use of this fuel.

Drying of Stud Timbers in Veneer Construction.—Tests conducted during both last summer and last winter confirm that stud timbers in veneer construction for domestic buildings do not require anything like the excessive ventilation that has been employed in recent years. Stud timber in sealed cavities has been found to dry out to less than 28 per cent. moisture content in a reasonable period of time, and to retain this degree of dryness thereafter provided direct leakage of water is excluded.

Physical Properties of Pinus radiata.—Testing of *Pinus radiata* in structural sizes supplied from the State Forest Mill, Rotorua, is proceeding. This work is being done in collaboration with the New Zealand Forest Service.

Foundation Rock.—Investigations of the physical properties of foundation rock from the proposed dam-sites at Whakamaru and Atiamuri and from the Auckland Harbour Bridge footings have been proceeding. A study is being made of triaxial shearing test techniques with full and partial pore pressures.

Concrete.—Early in 1950 the Concrete Laboratory was sufficiently completed to permit work to be started. Initial work on dense and lightweight concrete is being done by comparing certain mix designs with and without the use of proprietary admixtures.

GEOPHYSICS RESEARCH AND INSTRUMENTATION

Earth Current Measurements.—Between August and November, 1949, recordings of earth potential gradients have been made at points on the coast near Karori Stream mouth and Makara Radio Station, to investigate possible correlations with tidal currents in Cook Strait. Some of the resulting records, together with actual measurements of tidal stream velocities, have been analysed and have given definite evidence of tidally-induced earth currents of the order of 7mV./Km./knot.

Measurement of Solar and Sky Radiation Received at the Earth's Surface.—Absolute measurements of the spectral energy distributions of radiation from the sun and sky have been made for various elevations of the sun. The same equipment has enabled determinations of the spectral energy distribution of artificial sources of radiation to be made in connection with experiments at the Plant Chemistry Laboratory on the artificial growing of plants.

Shaking-table.—Equipment for testing vibration-measuring apparatus over a range of frequencies (0 to 100 cycles per second) and amplitudes (10^{-3} to 10^{-6}) in.) is being built. At present rates of progress it is probable that the laboratory accommodation planned for the table at Moore's Valley will not be completed by the time the table is ready for its first tests.

Geophysical Field Laboratory, Moore's Valley.—A special hut for magnetometer testing, observations of terrestrial magnetism, &c., constructed entirely from non-magnetic materials, has been erected at a suitable point, and is now in regular use. A second slightly larger hut has recently been erected near the upper edge of the grass clearing, and this is intended ultimately for use as a store and accommodation building. Pending the erection of the main laboratory hut and power-house, it is also acting as a temporary laboratory. A store for explosives and two equipment hutches are also installed at suitable points. A wind-charger plant has recently been installed and is being run to charge batteries and to gain some information as to its possible utility for supplying field installations in remote areas. Recordings of short-period atmospheric pressure fluctuations have been made at intervals over the past few weeks with the battery-operated microphone barograph.

Air-borne Magnetometer.—This instrument is to be operated by Magnetic Survey for geophysical survey work, especially in thermal regions, after it is installed in an aircraft and operating satisfactorily in the air. After the instrument arrived from England in November it was operated satisfactorily on the ground, and is being installed in a Miles Aerovan aircraft made available by the Air Department.

Time-pips Selector.—An instrument is being developed for installation at seismograph stations to enable the broadcast time signals to be automatically recorded, thus giving increased accuracy in determinations of the times and epicentres of earthquakes.

Fluxgate Magnetometer Development.—Simplified equipment for measuring the strength of the earth's magnetic field on the ground, for use in field surveying and at ionosphere stations, is being developed.

RADIO RESEARCH

Radio-path Investigation.—Since May, 1949, this laboratory has been carrying out a continuous programme of simultaneous measurements of absorption of radio waves reflected by the ionosphere at oblique and vertical incidence. The oblique incidence path lies between Awarua and Lower Hutt, and the vertical incidence measurements are made near Christchurch, approximately at the point of reflection of the oblique incidence radio waves.

The aim of the project is to resolve a discrepancy between theory and practice which was discovered during preliminary trials, and eventually to improve the accuracy of prediction of short-wave conditions over short paths (less than 2,000 miles) in the New Zealand area. Analysis of results has confirmed the existence of the discrepancy, the magnitude of which appears to vary throughout the day.

Medium-frequency Ground Conductivity Survey.—This project constitutes a survey of the electrical conductivities of New Zealand soils over the frequency range 100–1,500 Kc./s., and has been undertaken at the instigation of the Radio Research Committee. (Radio waves decrease in strength more rapidly when travelling over low-conductivity soils than when travelling over high-conductivity soils.) When completed, this survey will enable reliable estimates of the coverage of projected broadcasting and radio navigational-aid transmitters to be made in advance.

The survey of the southern portion of the North Island is completed, and it is hoped that the whole of New Zealand will be covered within the next three years.

Study of Maximum Usable Frequencies.—On behalf of the Australian Ionospheric Prediction Service, this laboratory is making regular measurements of the times when reception of transmissions from Radio Australia cease at night (skip-times). The information is used by the I.P.S. to improve the accuracy of their predictions of the maximum usable frequency for night-time conditions over a distance of 1,500 miles.

Radio Research Office.—This office continues to collect and correlate radio research information, and to supply the Navy and the New Zealand amateur radio organization with routine predictions of frequencies for fixed circuits.

Since June, 1949, a *Cosmic Relations Bulletin* has been issued monthly, and is being supplied regularly on request to eighty-four overseas research laboratories. This bulletin contains collected information on radio reception conditions, magnetic and ionospheric disturbances, solar activity, and auroræ as observed by co-operating organizations within New Zealand and its dependencies.

Microwave Propagation Tests.—The object of these tests is to obtain on behalf of the Post and Telegraph Department operational knowledge of the suitability of 3 cm. and 9 cm. wave-lengths for communicating across Cook Strait in the first instance. A transmitting-station has been established at Blind River, near Seddon, and a receiving-station with continuous recording at Buckley Road, above Island Bay. Continuous records of 9 cm. operation have been obtained since the end of September. The 3 cm. records are rather intermittent owing to instrumental difficulties.

ENGINEERING RESEARCH

A permanent hydraulics laboratory has been established in one of the large stores buildings near the main laboratory. Earlier work on hydraulic models for the Ministry of Works was carried out in the open, and the new laboratory provides a great improvement in working conditions. Up to four model set-ups can be accommodated at one time, and testing is being carried on by Ministry of Works and D.S.I.R. staffs.

Maraetai and Cobb River Spillway Models.—Both of these series of model tests were completed during the year.

Maraetai Penstock Models.—Tests are being made to determine whether one of the Maraetai penstocks can take the whole river flow while the diversion tunnel is being plugged and converted into a spillway.

Tests on the penstock itself are now complete, and preparations are under way for a further series of tests on the river-bed downstream where the penstock discharges into the river-bed.

Roxburg Spillway Models.—A preliminary study of a section through Roxburgh spillway is being made in a glass-sided channel so that flow conditions can be observed and, if faulty, corrected. Preliminary tests have shown modifications to be necessary, and these are being made.

Roxburgh Dam and River Models.—This is a study of the whole of the proposed installation at Roxburgh. The model has been completed except for the spillway block. When the latter is installed, tests will be run to check the general performance and flow conditions in the river-bed, in the diversion channel, and over the spillway.

Heat Pump.—A working model of a swimming-bath installation has been built and exhibited at Christchurch, Hamilton, and Auckland. An experimental unit is being installed at the laboratory for heating an office by circulating hot water in pipes under the floor. Applications of the heat pump to the dairy industry are being investigated in conjunction with the Dairy Research Institute.

Strain-gauging of Engineering Structures.—Work is being carried out on the use of resistance strain-gauges for long-term investigations, and on their protection from moisture when used for such applications as measuring the strain in reinforcing-steel in a ferro-concrete building.

Embedded Strain-gauges.—A prototype model has been completed and is undergoing stability tests. The design of the auxiliary electronic units has been completed and the first set is under construction. The design of a gauge assembly for quantity production is being examined.

Vibrations of Engineering Structures.—This work is concerned with the effects of earthquakes and other vibrations on structures. A general-purpose seismograph or vibration meter and a mechanical shaking-table for testing vibration-measuring equipment have been designed and are being built. A mechanical vibrator for investigating dynamic characteristics of soils and structures has been built, tested, and used successfully in the field by the Geological Survey.

METALLURGY

A wide range of queries and investigations has been handled, together with advice and practical assistance on heat treatment of metals and alloys, mechanical testing of metals, metallography, deposition of metals, radiological examinations, foundry practice, assessment of welds, investigation of service failures, hot and cold working of metals, and surface treatment of metals.

A number of firms have been visited in connection with difficulties in the manufacture of castings, forgings, pressings, and structural members.

Lead Reclamation.—The design, construction, and testing of an improved type of furnace for reclamation of lead from car batteries has been satisfactorily finalized.

Moulding-sands.—Extensive tests on the properties of local moulding-sands have been started. Green Island sand has been chosen for the initial examination, which will be conducted in accordance with standard foundry procedure. The reaction of the various molten alloys on this sand will also be studied.

Ironsands.—Technical assistance and advice have been given to the State Iron and Steel Department in connection with the smelting trials at Onekaka in 1949. Some independent research has been carried out.

DESIGN

Fractionating Molecular Still.—An experimental model of a new type fractioning molecular still has been built, and tests are now being made of its fractionating power. Successful development of this type of still will allow molecular distillation to enter fields not now open to it, and should also increase the recovery of vitamin A from fish-liver oils from the present 70 per cent. to better than 90 per cent.

Regulated Power-supply.—A power-supply for the Standards Laboratory, stable to 1 part in 10,000, has been designed and developed. Initial tests have been carried out in the laboratory, and mechanical details for the final model are almost complete in the workshops.

Simple High-speed Mechanical Counter for Aircraft.—An instrument was required to count at rates up to 20 per second and to be unaffected by vibration. A prototype instrument has been built and proved very promising. A new design incorporating the use of a standard case size, concentric pointers, and acceleration compensation is in hand.

Maraetai Temperature Units.—A set of thermometers was supplied to measure the temperature of concrete as it was setting in the Maraetai Dam. Ninety copper resistance elements were made up and housed in short lengths of water-pipe. The indicator used was a Wheatstone bridge with the slide wire wound on a drum and calibrated directly in Fahrenheit degrees.

Special Anemometer.—An anemometer for recording very low wind speeds has been designed by using a photo-electric system and electronic frequency meter to record the speed of the anemometer vane. The advantage of this system is that very light loading is imposed on the anemometer vane.

Plant Lighting.—Apparatus is being developed for supplying plants with artificial sunlight when growing in enclosed cabinets. In addition to soil nourishment, warmth, air, and moisture, plants require light to sustain growth. A battery of fluorescent lamps is being arranged to fit inside a totally enclosed cabinet. The light unit has water and air cooling to prevent convected or radiant heat from reaching the plants.

Grease-kettle Thermocouple.—A specially robust thermocouple head was developed for measuring temperature in large grease-kettles. The action of powerful stirrers in greases of high viscosity caused frequent failures of expensive and delicate heads imported from the U.S.A. A robust and satisfactory head was designed and built.

Temperature Measurement in Deep Bores.—Prototype equipment has been made for measuring temperatures in deep bores in the thermal regions. A special three-core electric cable for use at high temperatures is now to hand from Great Britain and will be used with a resistance thermometer and meter at temperatures up to 200°C.

Ultracentrifuge.—This high-speed centrifuge (60,000 r.p.m.) is now well advanced in construction, and is being assembled and tested. Tests of the Schlieren optical system have given very satisfactory results. The turbine unit has been given bearing tests, and has been held at 40,000 r.p.m. for some time. Rotors are still under construction.

Intervalometer Mark II.—A further model incorporating operational improvements has been designed and built following the successful results obtained with the original instrument that was supplied by the laboratory and used for timing camera exposures in aerial photography.

Timber-weighing Apparatus.—A direct mechanical method of determining moisture content of wood samples throughout timber stacked in a vapour drying-kiln is being developed. Samples are weighed at intervals by means of a pneumatic capsule.

OPTICS

Optical Design.—Research has been done on the theory of high-performance optical systems and design methods in order to reduce numerical computation to a minimum, with some notable results. This work was undertaken initially under the direction of Dr. F. D. Cruickshank of the Tasmania University.

Data on available English optical glasses have been examined for designing highly achromatic combinations.

Optical Workshop.—Apart from making components for new optical systems, some reconditioning work is done, mainly on the highly skilled work of polishing scratched surfaces on photographic lenses.

Optical Testing.—Special apparatus is under construction both for testing the general performance of optical systems and for evaluating individual aberrations.

ELECTRON MICROSCOPE

Several improvements in the electrical circuits of the microscope received from the makers are now being incorporated, and should improve its performance.

Research in conjuction with the Dairy Research Institute is in progress on the action of bacteriophage on the bacterial " starters " used in the cheese-factories. Other work includes particle sizing of paint pigments for local industry, and of ceramic materials for the New Zealand Pottery and Ceramic Research Association, in addition to studies on soil colloids and spermatozoa of bulls.

ELECTRICAL AND ELECTRONIC DEVELOPMENT AND TESTING

Ultra-violet Radiation Integrators.—Integrators of the original design were used to compare solar and sky ultra-violet radiation at Lincoln and Lower Hutt during July, 1949. No significant difference was detected, but instrumental inconsistencies appeared which could have obscured small differences. Accordingly a complete redesign was undertaken, and the resulting much-improved equipments will be used for further tests in 1950.

Quartz-crystal-controlled Clock.—The first model has given long and satisfactory operation in the laboratory. It has now been transferred to the Seismological Observatory for use in the time service. A second model is complete except for a new oscillator incorporating a high-quality crystal which is expected from the United Kingdom.

Quartz-crystal Preparation.—Techniques of activity measurement, X-ray examination, etching, plating, and wire mounting *in vacuo* have been developed, at the request of the Post and Telegraph Department.

Mental Therapy Electric-shock Unit.—The prototype unit providing " brief stimuli " facilities, requested by the Department of Health, has been completed and delivered.

Radiography Timer.—The automatic exposure timer for use in X-radiography and photofluorography, developed at the request of the Health Department, has been completed and delivered. Final adjustment is awaiting the convenience of the Health Department.

Magnetic Amplifiers.—A more exhaustive study is now in progress into this method of power control by means of small direct currents. The method offers the most promising approach to the amplification of low powers from low impedance sources. A circuit now developed permits the full-scale deflection of a 0–1 milliamp-meter from a thermocouple with a temperature change of 20°C. A power-control circuit giving an output of 15 watts for an input of 0·05 watt has also been developed; this can be considerably improved by the use of better magnetic materials. There appears to be a wide field of useful application for both these types of circuit.

Detection of Small Metal Objects.—A request was received from the Wellington Hospital for assistance in detecting small foreign bodies inside the eye during operations. A sensitive amplifier with suitable frequency response, used in conjunction with a small probe, was found to be effective and was supplied to the hospital.

Crystal Triodes.—Sample crystal triodes were received from the United Kingdom by the courtesy of the manufacturers. Tests, while not conclusive, indicated that these triodes have not yet reached sufficient repeatability and stability to be suitable for practical applications.

Tests on P.V.C. Overhead Power Cables.—A sample of P.V.C. insulated aerial cable and two types of braid-covered aerial cables were subjected to 2,000 hours accelerated ageing. The electrical and physical properties of the P.V.C. cable compared favourably with those of the other cables.

Routine Testing.—Testing of electrical equipment and commodities has formed a steady activity; these included switches, fuses, water-heater elements, hot-plates, switchboard materials, and motors.

INSTRUMENTATION FOR NUCLEAR PHYSICS

Geiger Muller Tubes.—An improved vacuum system has been constructed and put into operation. This enables more accurate filling of the tubes and also quicker location of leaks in the assembled G.M. tubes. Tubes with excellent characteristics can now be constructed in a small range of special types.

Health Instruments.—Several laboratory radioactivity monitors have been placed in service in radio-isotope laboratories. These instruments are designed for checking the occurrence of any appreciable contamination of the laboratory or operator's clothing. A prototype ionization chamber monitor for beta and gamma radiation has also been built, and six more are to be made. This instrument measures the direct radiation from isotopes so that the operators can check that the radiation level they are receiving is always below the permissible tolerance dose.

Field Monitor.—A portable beta-counting instrument has been designed and constructed for the Soil Bureau. This instrument is now being used for preliminary measurements in the field with radioactive phosphorus.

Scintillation Counters.—Work has commenced on the technique of growing organic crystals, and on their use as detectors of radioactivity.

Mass Spectrometer.—A start was made towards the construction of a general-purpose mass spectrometer in November, 1949, but some delay was experienced while waiting for the arrival from England of materials and for

reports and data to be used in the design. Design and construction of the various units has commenced, and the next twelve months will see considerable progress. The mass spectrometer is to be used for biological and other research in which stable isotopes imported from overseas atomic energy stations will be employed.

PHYSICAL INSTRUMENTATION

The year has shown a great decrease in the amount of external servicing work done for industry. This is partly due to the Laboratory's efforts to divert this work to commercial agencies, and partly due to the natural development of these instrument-servicing organizations. The diversion of the work from the Laboratory is undoubtedly helping the commercial concerns to set themselves up. Assistance is still given in any case where commercial aid is impossible. The present main work of this laboratory is thus the development of instruments for internal use, for Government Departments, and other laboratories. A notable improvement in the conditions under which instruments are developed has been possible through extra space being allotted to the laboratory.

Current Developments.—Air systems for amplifying small mechanical movements, especially those of low effort. These systems provide an alternative to electrical and electronic methods of indication and control. Use is being made of two types—one using air-pressure indication and the other air-flow indication. The systems are to be used in general laboratory instrumentation, in an instrument for measuring the fineness of a bulk sample of wool fibres, and in load-measuring capsules.

Load-measuring capsules for earth pressure and related measurements and for compact weighing devices.

A " velocity against gravity " recorder for use in aircraft.

Development of the blood-pressure-recording equipment has been continued, and a trial has now been made under hospital theatre conditions. This instrument is being developed for specialized medical use.

Frost-alarm development has continued past the trial stage and a pre-production batch of instruments is being made for the next frost-fighting season.

RADAR

Canterbury Project.—In this project, which is an investigation of anomalous propagation of radio waves under north-west wind conditions in Canterbury, the collation of results into a form suitable for permanent recording has been completed, and one officer has been seconded to the Telecommunications Research Establishment in England to work on the theoretical analysis.

Microwave Meteorological Radar M.E. 7.—The service manuals have been completed and distributed. Installation of the second two sets has been delayed by building difficulties; however, the fourth set is now to be installed at Harewood instead of Palmerston North, so final installation may be accelerated. One of these equipments has been temporarily installed at Shelly Bay for staff training.

As far as is known, this equipment still has a higher operational performance than any other set used for wind-finding overseas.

Subsidiary Meteorological Radar.—An experimental equipment was constructed, using a surplus airborne 3 cm. wave radar type ASD and a 4 ft. paraboloid mounted on a gun turret. Performance was satisfactory in following a standard 17 in. target to 30,000 yards with adequate accuracy. It was decided, however, that the surplus radar parts were too unreliable and the cost of modern commercial replacements was too high, and since the operational requirement became less important the project has now lapsed.

Vehicle-speed Indicator.—Some modifications resulting in higher accuracy and greater operational ranges have been made to the equipment during the year. The speed of trucks and buses may now be determined at ranges of some hundreds of yards with an accuracy of the order of two miles per hour. The equipment has been used continuously by the Transport Department with considerable success, and tenders have been called for construction of one or more additional sets.

STANDARDS

Instrument Calibrations.—Instrument and other calibrations performed during the year number approximately 230, certificates having been issued for a large number of these. Many of the instruments which have been inspected are of " working " quality, and the number of high-grade substandards submitted is still small. Of the number above, some 95 were electrical calibrations, 31 were connected with linear standardization, 11 with temperature standardization, 10 with mass, and 17 with various other standard measurements. A total of 83 limit gauges for engineering production have been inspected.

Calibrations and other " pure " measurements continue to occupy most of the time of this laboratory.

Temperature Standards.—Main items of equipment are still awaited from overseas, and activities are confined to the preparation of the various " fixed points " that define the temperature scale. A furnace for realizing the gold point (1063°C.) was built during the year, and has been used for standard thermocouple calibrations at this temperature and for investigating thermocouple contamination. A number of standard thermometers is still to be returned from Australia, where they are being re-calibrated.

Standard Cells.—In conjunction with routine calibrations of standard cells, which are basic to electrical measurements, a study was made of the thermal sensitivities of cells of various types, and this has resulted in better techniques of calibration at the laboratory. In this work, cells were kept at various temperatures and accurate comparisons made more or less continuously for a week with the laboratory standards. The electromotive forces of both saturated and unsaturated cells were measured, and the various " hysteresis " effects peculiar to the cells were demonstrated.

General Metrology, &c.—In addition to the routine servicing work summarized above, work has been done on the stability of various drawing materials used for making profile layouts; on the surface finish of ground and lapped quartz crystals; on various hydraulic systems of force measurement; on the refractive index of butterfat; and on the use of electrical anemometers in relation to the flow of air in pneumatic amplifying systems. An interferometer for studying the thermal properties of refractory materials is being prepared for the Pottery and Ceramic Research Association.

A notable addition to the " engineering " standards is a 7-ton stack of dead-weights that enables calibrated lever systems in force measurement to be dispensed with. The machine is used almost exclusively for standardizing the portable " loadometers " used by transport licensing authorities to control vehicle loading. The machine gives greater accuracy than is possible with lever systems.

New equipment for testing speedometers is also being put into commission.

Equipment.—Standardized equipment commissioned during the year includes an a.c. potentiometer standardized by N.P.L., tungsten-filament lamps with radiant energy calibrations from the U.S. Bureau of Standards, thermometers re-calibrated in the range 0–100°c. by N.S.L. in Sydney, precious metals for international temperature scale definition, and a Secondary Frequency Standard (Marconi Type T.M.E. 1).

Equipment about to be put into use includes a universal dynamometer voltmeter standardized by the N.P.L., and a 0–4 in. slip gauge comparator.

PUBLICATIONS

The following reports have been compiled during the year (these are additional to test reports and certificates) :—

No.	
8/7/89	Operating Manual for Signal Frequency Ionosonde.
8/7/90	Some Methods of Casting Tin Base Alloys.
8/7/91	Visit to the Radioactivity Centre N.I.T. during 1948.
8/7/92	Effects of Earthquakes on Dams.
8/7/93	Building and Ground Vibrator.
8/7/94	Geiger-Muller Counter Development.
8/7/95	Resistance Thermometer Units for Maraetai Dam.
8/7/96	Some Notes on Tool Design.
8/7/97	M.E. 7 Microwave Meteorological Radar Manual.
8/7/100	Comparative Ultra-violet Radiation Measurements at Lincoln and Lower Hutt.
8/7/101	Magnetic Separator.
8/7/102	Triaxial Testing of Soils and Rocks.
8/7/103	Transmission of Light Through Fog.
8/7/104	The Secondary Spectrum for Some Pairs of Chance Glasses.
8/7/105	A Short Stimulus Shock Therapy Machine.
8/7/106	Valve Tester—revised manual.
8/7/107	The Behaviour of Special Miniature Unsaturated Cadmium Cells.
8/7/108	The Technique of Wire Mounting Plated Quartz Crystals in Evacuated Holders.
8/7/109	A Smoke Density Recorder.

The following publications by the staff have appeared this year:—

Physical Review, Vol. 76, 1, 1st July, 1949: " Variation of Meson Intensity with Height." P. H. Barker.

N.Z. Journal of Science and Technology, Section B, Vol. 30, 3, November, 1948: " The Measurement of Sola plus Sky Ultra-violet Radiation," and " Estimations of Hourly Values of Solar Ultra-violet Radiation in New Zealand." E. R. Cooper.

Electronics, Vol. 21, 1, January, 1948: "Radiosonde Potential Gradient Measurements." R. Belin.

Nature, Vol. 163, 4153, 4th June, 1949: "A Photo-electric Wool Staplemeter." R. Belin.

Physical Soc. Proc., Vol. 60, 381, 1948: "A Radiosonde Method for Atmospheric Potential Gradient Measurements." R. Belin.

N.Z. Science Congress, 1947—

"Some Physical Principles Affecting Housing." L. Bastings.
"X-ray Diffraction of Ironsand." N. Rumsey.
"Principles of Molecular Distillation." K. I. Williamson.
"Instrument Testing and Development." G. S. Marshall.
"A New Optical Polishing Abrasive." G. F. Dainty and R. L. Jones.
"Analytical Balances and their Faults." J. W. Humphries.
"General Principles of Radar Design." A. G. Bogle.
"Radar and Radio Methods of Position-fixing and Navigation." D. M. Hall.
"Radar Display Circuits and Techniques." P. H. Barker.

Journal of Scientific Instruments, Vol. 26, 10, October, 1949: "Measurement of Radiation Falling on a Flat Surface." E. R. Cooper and M. Probine.

Journal of Scientific Instruments, Vol. 26, 12, December, 1949: "A Sensitive Vapour-pressure Thermoregulator." W. R. B. Martin.

Journal of Scientific Instruments, Vol. 26, 4, April, 1949: "A Minute Light Spot." F. Stafford.

N.Z. Journal of Science and Technology, Section B, Vol. 30, 3, November, 1948: "Note on Investigation on the Use of Supersonic Pulses for Measuring Thickness." J. Templeton.

Proc. N.Z. Institution Engineers, 1949: "New Zealand Meteorological Radar." A. G. Bogle.

ENTOMOLOGICAL RESEARCH STATION

Director: Dr. D. Miller

GRASS-GRUB

The investigation of various phases of this problem occupies more staff than any other project.

Insect Parasites.—The officer stationed in Australia has covered a wide area in Victoria and New South Wales with the object of studying and locating collecting-grounds for those parasites of Australian grass-grubs that give promise of usefulness in New Zealand. These are shipped by air as adult insects, and during the past season fifteen consignments totalling 3,346 insects were sent. More parasites were shipped than in 1948, and a desirable feature was that they were received earlier and synchronized better with the New Zealand grass-grub. Ten species of thynnid parasites were represented, and more than 80 per cent. of these parasites survived the journey.

In New Zealand, surveys were made of grass-grub infestations to locate suitable areas for liberation of parasites, and the different species of parasites were tested in the laboratory on New Zealand grass-grub to obtain an indication of possible usefulness. The parasites are not amenable to mass production in the laboratory and the procedure is to liberate the imported material in the field. Over 1,100 females belonging to five species were liberated in the Nelson district and at Raetihi, the choice of locality being determined by the availability of grass-grub infestations at a suitable stage. A few parasite individuals have been recovered from the field at Nelson and Ashburton, indicating that the parasites have completed one generation on the New Zealand grass-grub, but it is not yet certain that they are permanently established.

Nematode Worm Parasites.—Large-scale rearing of the nematode (*Neoaplectana glaseri*) introduced from the U.S.A. is now under way in preparation for field trials of this organism against grass-grub. Another native nematode is also being studied.

Chemical Control.—Tests of soil insecticides against the grubs have been carried out with several materials. Of these, Chlordane is the most promising as regards efficiency and cost, but high cost is still a serious obstacle to the use of the material under Canterbury conditions, though on the higher-productivity dairying pastures of the North Island it may be economic.

Field tests have also been made of the effectiveness of insecticidal treatments in killing beetles during the flight period and of the effect of the reduction in beetle numbers on the number of grubs produced. Significant reductions in both beetles and grubs were obtained, but the efficacy and practical economics of the treatments have yet to be assessed.

Biology and Ecology.—Information is being accumulated on the flight period and habits of the beetle. A large experiment was laid down in co-operation with the Department of Agriculture designed to show the effect of irrigation on the abundance of grass-grub.

GRASS-CATERPILLAR

The results from large-scale field trials this year indicate that the use of gammexane incorporated in superphosphate as an autumn top-dressing will replace the use of the poisoned bran baits used previously. This is an important development which has immediate effects on production. The new control measure gives better results than the old one for the same or a lower cost, and avoids the impasse due to shortage of bran. It has been taken up immediately by farmers, and a move has been made to have the gammexane incorporated with the super at the fertilizer-works.

MANUKA BLIGHT

Over the past three years the insect believed to be causing the death of manuka in South Canterbury has been widely distributed in both Islands by farmers. In at least some cases the insect has become established in these new localities. In one case, where the insect is established from liberations made three years ago, some of the manuka has already been killed. There are strongly differing opinions on the desirability of this spread, but there is at present no legal ground for preventing it. No success has been obtained in determining the origin of the insect—whether native or introduced.

ARMYWORM

The native armyworm was present in increased numbers in oat and wheat crops. This insect also does serious damage to seed crops of rye-grass, and the development of a satisfactory control is highly desirable. Reasonably good control was obtained this year with a gammexane-bran bait, but further work is required.

PHORMIUM FLAX INSECTS

An officer is stationed at Foxton as one of a team investigating the causes of "yellow-leaf" disease in flax. A survey of the insects associated with flax has been followed by experiments with field-collected material of three insects that could be vectors of a virus, though it is not yet proved that the disease is caused by a virus. A survey has also been made of flax insects in North Auckland.

GREEN-VEGETABLE BUG

This insect is spreading and becoming increasingly destructive. A survey made this year showed that the parasite introduced from Australia last year is established in at least one locality in North Auckland. It is highly desirable that at least one other parasite of this pest should be introduced.

TOBACCO-LEAF MINER

This insect, also known as potato tuber moth, caused severe damage to tobacco in the rosette stage. This was checked by DDT dusting. The life-history and ecology of the insect in the field are under investigation. A parasite obtained from Australia has been liberated in the affected area.

HORNTAIL BORER IN PINES

The annual distribution of the parasite already established in New Zealand has been continued. An officer of the Station is to serve on the committee recently set up to consider the role of the borer in pine forests and methods for its control.

STORED-PRODUCTS INSECTS

The accumulation of material and information relative to existing stored-products insects in New Zealand has been continued. A paper dealing with the identification and economic importance of the Australian carpet beetle, not previously reported from New Zealand, has been submitted for publication.

WEED CONTROL

A recent survey shows that the ragwort-seed fly is established in the Putaruru area.

The distribution of the St. John's Wort beetle has been continued. This year material was sent to several localities in the North Island.

MISCELLANEOUS

A study of the tick fauna of the New Zealand region has been made and is being prepared for publication. A preliminary investigation has been made of soil treatments for the control of Collembola, which caused severe damage to germinating vegetables in Nelson. Efforts to discover the breeding-place of

the principal sandfly pest in the South Island have been continued, but so far without success. Preliminary work has been done on two other insect pests that were prominent this season—the spider mite in raspberries, and the wheat bug, which causes both sticky-dough in wheat and failure of young cruciferous crops.

WORK FOR OTHER DEPARTMENTS

Island Territories.—An officer was loaned to the Samoan Administration to investigate and report on the coconut beetle problem in Western Samoa. Following this a survey was made of the insect pests of economic plants in Rarotonga.

Tourist.—An investigation and report was made on the probable effect of certain proposed work in the Waitomo Cave on the glow-worm population.

Agriculture.—All possible assistance has been given to the Department of Agriculture in its proposals to revise the existing quarantine system.

FATS RESEARCH LABORATORY

Director: Dr. F. B. Shorland

During the past year the main attention of the Laboratory has been directed, in collaboration with the Dairy Research Institute, towards the elucidation of the nature of butterfat. Various other fats of direct economic interest have also been studied, and, in particular, increasing emphasis is being placed on meat fats as a part of the New Zealand contribution towards the collaborative British Commonwealth work on meat.

BUTTERFAT INVESTIGATIONS

The comprehensive survey on the seasonal variations in the fatty acid composition of butterfat has been continued and existing knowledge has been further extended. For this work it has been necessary to devise improved techniques, and a paper on this aspect, covering the work over the past three years, has been prepared for publication.

Significant advances have been made in the elucidation of the nature of the highly unsaturated C18 and C20 acids, which are important in connection with the development of rancidity of butterfat. It has been found that the sample of New Zealand butterfat investigated contained about 1 per cent. of octadecatrienoic acid, as compared with less than 0·1 per cent. in the English butterfat studied by other workers. The unsaponifiable matter of butterfat has been further investigated, and a sterol exhibiting the properties of cryptosterol has been isolated.

Owing to the absence of staff overseas, the study of glyceride structure has been temporarily suspended.

TALLOW

Further tests on the high-vacuum short-path distillation of tallow fatty acids for stearine-manufacture have been carried out, and these indicate considerable advantages over the methods at present in use. In due course it is hoped that the method worked out in this Laboratory will be applied to the industry and so increase the yield and improve the quality of the product. Inquiries have been made by freezing-works regarding the methods of grading tallow, which at the present time are not satisfactory, and it is hoped, in association with the Standards Institute, to make a study of this problem and evolve satisfactory methods of grading.

FISH-OIL INVESTIGATIONS

From the improved techniques evolved in this Laboratory the efficiency of oil extraction has been improved, and yields up to 20 per cent. better recovery of vitamin A have been obtained in factory tests. Papers relating to this work have been forwarded for publication. Following the successful manufacture of an egg-white substitute from fish protein, it was found that similar techniques were applicable to casein, which was more suited to New Zealand conditions than was the more expensive fish protein.

MISCELLANEOUS

In a general study of the relationship between the dietary and depot fats of farm animals, it was found that some species, such as the ox and the sheep, lay down fats that are relatively unaffected by those present in the diet, while the fats of other animals, such as the horse and pig, are readily altered by the nature of the dietary fat. To distinguish between these two types of animal fats, the terms "heterolipoid" and "homolipoid" have been proposed, and a paper on this subject has been forwarded to *Nature*.

New techniques for fractional distillation of heat-sensitive substances have been developed for the purpose of assisting in the isolation of the higher unsaturated acids of butterfat, as well as for industrial application.

FRUIT RESEARCH STATION

Director: Mr. J. D. Atkinson

Development work has been pushed forward on all four research orchards. A total of 388 fruit-trees for various experimental purposes was planted during the year, and additional shelter-trees have been set out on two orchards. At Havelock North all rubbish and old stumps have been cleared and the land fallowed preparatory to planting; necessary vermin-proof fencing has been extended at Havelock North and Appleby; and contour lines have been ploughed in on the Appleby contour block and new areas broken up for dwarf trees and stone-fruit. The Earnscleugh manager's house is nearing completion. New orchard equipment has helped to relieve the labour problem. The Botany Division has established experimental plots of phormium and *P. radiata* at Appleby and of grass at Earnscleugh, and an extensive programme of disease-control experiments has been carried out on the orchards for Plant Diseases Division.

PHYSIOLOGY

Results from the Appleby manurial trials on apples are being examined statistically. Some short-term blocks that have given answers to specific questions have been switched to other uses.

Field trials are in progress in an attempt to diagnose a number of fruit-tree diseases suspected of being mineral deficiencies. Apple-trees on Northern Spy stock will seldom grow successfully in holes formerly occupied by trees on this stock, and experiments are being undertaken to discover the cause of such failures. An area of the Appleby Orchard is being sown in grass to test the merits of keeping orchards under permanent grass as opposed to the present practice of clean cultivation during the summer with a winter cover-crop.

A range of treatments designed to improve alkaline soils in Central Otago has been applied, but there has not yet been any measurable improvement in tree performances.

Results from the artificial freezing of apricot blossoms have been consolidated and published, giving a guide to the temperatures that blossoms and young fruit will stand without injury. Field tests of two frost-alarms were carried out for Dominion Physical Laboratory, and both alarms gave good results. Collection of data for frost forecasting continues, and there are indications that some forms of frost can be predicted with fair accuracy. The possibility of reducing frost risk by delaying blossoming of apricots with hormones is being studied.

Attempts are being made to develop standard biological tests for the synthetic plant hormones used for setting tomato fruits and for preventing pre-harvest drop of apples. The objective is to develop means of measuring the relative efficiency of various proprietary brands offered for sale. Effects of hormones on citrus, grapes, and beans are also being investigated.

Further experiments on the chemical thinning of apples have shown that practices recommended overseas are liable to cause serious injury, and must be modified for our conditions. The long blooming period typical of New Zealand apples introduces a complication that may prevent the general adoption of this practice.

POMOLOGY

Two new apple rootstock trials, incorporating vigorous woolly-aphis-resistant stocks, have been planted at Earnscleugh. Varietal trials of lemons, including the Perrine lemon, have been set out at Mount Albert and Kerikeri.

A selection of three cold-resistant apple rootstocks was introduced from Canada for trial in Central Otago. Three plum stocks from England are being propagated for trial as dwarfing stocks for stone-fruits.

VIRUS INVESTIGATIONS

In co-operation with Plant Diseases Division, further work has been done on the separation of fruit-tree virus diseases from physiological troubles. It has been demonstrated that one form of apple fruit-distortion is caused by a virus, and detailed results are now awaiting publication. Surveys in Hawke's Bay and Central Otago have shown that at least one stone-fruit virus is widespread but does not appear to be causing serious trouble.

MISCELLANEOUS

Blending juice from true cider varieties with juices normally used has not materially improved the quality of local cider. In the field several of the cider varieties have proved particularly susceptible to fireblight. For these reasons it is uneconomical to grow cider varieties, and the work has been stopped.

Tree wound dressings incorporating fungicides and materials intended to stimulate callus formation are under trial in Hawke's Bay. Some striking improvements in the rate of healing have been obtained, but the resistance of these dressings to fungous attack is not yet known.

Two types of acetylene-operated mechanical bird-scarers were tested in Otago cherry-orchards, but both developed mechanical faults. One of these machines can be improved easily, but the design of the other may have to be altered. It was shown that equipment of this type will keep most birds away from ripening cherries over a radius of 2 to 3 chains, but a small amount of supplementary shooting is required. Practical difficulties in erection prevented the overhead travelling version of this device being put into operation during the past season.

GEOLOGICAL SURVEY

Director: Mr. M. Ongley

Increasing numbers of requests for information and guidance on the availability and development of raw materials required by industry, on problems of water-supply, and on economic and engineering geology, in addition to the systematic regional mapping and investigation of New Zealand coalfields, have kept the staff fully taxed throughout the year. Additional staff has been recruited from overseas, and the clerical and library staff strengthened; two geologists have resigned.

Close collaboration on many subjects was maintained with the Dominion Laboratory and with other Departments.

REGIONAL GEOLOGY

Regional geological mapping, which serves as the basis for an assessment of the potential resources of the country, has been extended to the Hokianga area, and knowledge of the perplexing structure and stratigraphy of the North Auckland district has considerably advanced during the last few years through detailed field investigation combined with palæontological research. Work on the Motatau Subdivision is completed, and a bulletin is being prepared.

A bulletin on the Dannevirke Subdivision is awaiting publication, and field-work on the adjoining Te Aute Subdivision to the north is progressing.

The survey of the Hauroko Subdivision in Southland is complete, and a descriptive bulletin is in course of preparation. Field-work has been extended to the Greenhills, East Gore, and Mataura Valley.

Bulletins describing the geology of the areas contained within the "provisional 1 mile" map series of the Heaphy, Karamea, and Geraldine sheets, as well as one describing the coastal area between Bruce Bay and Haast River, await publication.

A revision of the West Coast Tertiary stratigraphy, embodying the results of the past seven years' investigations in that area, is in preparation, and two papers on regional problems concerning the coal-measures are in the press.

The Alpine schists were investigated in the Haast Valley and Trent River, and a paper describing the fossiliferous Triassic and associated rocks of the latter locality is ready for publication.

COAL

Field-work commenced in the Huntly Coalfield in September, and a district office was established at Ngaruawahia. The immediate programme is to investigate the outcrop area of the coalfield to determine any possible extension of opencast areas or of workable coal adjacent to the present mines, some of which are approaching exhaustion of the known reserves. The long-term project is to assess the amount and quality of coal that will ultimately be available in the Huntly-Mercer basin, and to provide the background of information essential for the future development of the mining industry in that area. This is the general method adopted in all the coalfields, and the surveys are co-ordinated with Mines Department requirements.

At Ohai the work has largely been confined to the correlation of a large amount of drill-hole data, both for the over-all coalfield picture and for the prospecting of opencast projects.

Prospecting of the Southland lignites is progressing, but the programme is somewhat handicapped by the necessity in the meantime of confining drilling operations to Crown lands.

Considerable advancement has been made with the mapping of the Kaitangata Coalfield, and—pending the publication of the final report—information on certain areas is being mimeographed.

Activity on the West Coast has been confined to Reefton, Garvey Creek, Fletcher Creek, and Punakaiki Coalfields. Interim reports on these fields, as well as reports on further investigations in the Murchison district, have been issued.

VOLCANOLOGY

Routine investigation of the flow and chemical composition of water from wells and natural springs throughout the thermal regions has proceeded throughout the year.

Re-observation of activity on White Island indicates that apart from minor changes in the crater area there is little difference in the activity since observations were made in 1947.

The background of information provided by earlier investigators on the structure and history of geologic events in the thermal region of the Taupo and Bay of Plenty area is gradually being augmented by additional regional mapping, supplemented by geophysics and the various investigations in connection with dam-sites and the development of the hot-water resources. The overall picture, however, is far from complete and has not advanced to the stage where it can with any degree of confidence be utilized to investigate the potential thermal power available for industry. A concerted effort with the Ministry of Works is under way to test the Wairakei area as a possible source of thermal power for generation of electricity.

The officers who observed the recent eruption of Ngauruhoe are preparing a symposium for publication.

HYDROLOGY

Water-supply problems for local and public bodies, as well as for Government Departments, and industrial and private supplies, have been reported on throughout New Zealand; the number of investigations of such problems is ever increasing and is an important phase of the Survey's activities. A groundwork of information is accumulating that will serve for the future development and conservation of our water resources. It has been shown that some alleged deleterious effects of irrigation in Canterbury are due to excessive rainfall, and not the result of irrigation.

A paper on the "Conservation and Protection of Underground Water in New Zealand" was written for the International Water Supply Association.

ECONOMIC AND ENGINEERING

Investigations carried out during the year included those on limestones for various purposes, and greywacke and basalt for aggregate in the Waikato, on sands for glassmaking and moulding in Canterbury and Otago, on serpentine for the fertilizer industry at Wairere, on clay for ceramics at North Auckland and Orepuke, on bentonite for general purposes at Waimarama and Masterton district, on greywacke for coastal and river protection at Kaikoura, on clay and decomposed greywacke for bricks at Tawa Flat, on tuffs for pozzolanas at Oamaru and Te Kuiti, on antimony at Alexandra and Bannockburn, on copper sulphide at Waitahuna, on diatomite at Middlemarch, and on ironsands at Cape Foulwind. In addition, inquiries regarding available raw materials were attended to.

Landslides interrupting transport were reported on in the Wanganui and North Auckland districts. Hydro-electric projects were reported on in both Islands, and problems of bridge foundations and river erosion were investigated.

PALÆONTOLOGY

Collections of fossils sent in by the field geologists from many localities have been identified, the areas chiefly concerned being North Auckland, West Nelson, Westland, Geraldine, and Western Southland. Co-operation with the Universities continued, a considerable amount of palæontological work having been done for University student M.Sc. theses.

Work on the systematics of New Zealand fossils has continued as opportunity has offered, particularly in the micropalæontological study of the Ostracods from Tertiary strata, and of plant spores and pollens from lignites and coals. The co-operation of officers of the Botany Section in spore and pollen work has been of considerable help.

Two bulletins, "Tertiary and Recent Marine Ostracoda of New Zealand, Their Origin, Affinities, and Distribution," and "The Geology of Wanganui Subdivision" (containing a wealth of palæontological detail), were completed and are ready for publication. The following are being prepared: "Bibliography of New Zealand Geology"; "Index of Stratigraphic Names used in New Zealand"; and "Catalogue of New Zealand Mollusca, Fossil and Recent" (in collaboration with Mr. A. W. B. Powell, Auckland Museum).

Cataloguing, classifying, and labelling of the extensive Geological Survey collections of fossils have continued, and exchanges have been carried out with the official Government palæontological organization of France (Centre d'Etude et Documentation Palæontologique).

Study of fossil leaves and fruit, recommenced only recently after a long lapse, has unfortunately been interrupted by the resignation of the palæobotanist.

PETROLOGY

The Petrology Section has carried out many rock and mineral determinations and investigations for field officers, the Dominion Laboratory, the Soil Bureau, and the Dominion Physical Laboratory, and for the Ministry of Works, the State Hydro-electric Department, the Mines Department, and the Railways Department. Attention has been paid to the problem of the suitability of materials for use as aggregate with high- and low-alkali cement and with bituminous mixes. Building-stones have been examined and gemstones identified. Regional petrographic work was undertaken on the Murchison Subdivision, North Auckland, and on the area of Dun Mountain and D'Urville Island. Study of the ignimbrite sheets of the central North Island has continued, and a paper on "Andesite Rocks from Solander Island" prepared for publication. A paper on "Serpentinites, Spilites, and Associated Rocks of the Mossburn Area, Southland," is in the press.

GEOPHYSICS

The preliminary gravimetric survey of the North Island has established that the recently-acquired gravimeter will prove an invaluable instrument to assist in elucidating the geologic structure of New Zealand, particularly in areas where surface evidence gives little or no indication of structure at depth. Of more immediate importance is the gravimeter's application to the detailed investigation of the structure of the thermal regions and the Huntly Coalfield, where it is at present operating.

Seismic and magnetic methods were employed throughout the year to investigate dam-sites in both Islands for the State Hydro-electric Department, and foundation rock for the New Zealand Forest Service.

The paucity of gravity data in the South Pacific area was emphasized at the Seventh Pacific Science Congress; with the equipment now in operation the gap in the New Zealand area will be gradually filled.

DRAUGHTING SECTION

Maps and illustrations were completed to accompany geological bulletins on the areas of Dannevirke, of Bruce Bay and Haast River, of Geraldine, and of Ohai and Nightcaps. In addition, over 300 maps and diagrams were drawn to accompany geological reports and miscellaneous papers for the *Journal of Science and Technology*. New methods of draughting have been introduced which have enabled the draughting staff to increase the output of work and simplify the process of printing.

VISITORS FROM OVERSEAS

Overseas visitors to the Geological Survey included Dr. C. E. Tilley, Professor of Mineralogy and Petrology, Cambridge; Dr. I. C. Cookson of the University of Melbourne; and Dr. Katherine W. Palmer of the Palæontological Research Institute, Ithaca, U.S.A. Dr. Tilley, through the Nuffield Foundation, spent several weeks in New Zealand, and delivered a series of lectures embodying different phases of modern research as applied to geologic problems. Dr. Cookson, an authority on palæobotany, spent some time with those of the staff engaged on this research in an examination of New Zealand material. Dr. Palmer, visiting New Zealand on a Fulbright grant, inspected the Survey's fossil collection and discussed problems of stratigraphy and correlation with the palæontologists. During their excursions through the country these authorities were accompanied by different members of the staff; such contacts are of considerable value both to the specialists in these subjects and in furthering the work of the Survey.

GEOPHYSICAL OBSERVATORY, CHRISTCHURCH

Director: Mr. J. W. Beagley

The activities of the various units forming this Observatory were rapidly co-ordinated early in the year to fulfil our international obligations as far as the recording and distribution of basic geophysical data is concerned. The study of geophysical phenomena requires close international co-operation, for it can only be successful when observations are made all over the world. The accumulation of homogeneous ionospheric and geomagnetic data aids detailed analysis of associated ionospheric and geomagnetic effects. This analysis has helped considerably towards an understanding of the fundamental mechanisms causing such phenomena.

The data from this Observatory have proved to be of special importance to international organizations in geophysics. Their reliability is such that magnetic results obtained from Amberley are now used along with those of ten other selected observatories for determining the state of activity of the earth's magnetic field. This is associated with the complicated changes in the outer atmosphere which affect radio propagation. Ionospheric data from our three recording-stations at Lincoln, Campbell Island, and Rarotonga are used by the world centres for forecasting radio communication conditions.

ACCOMMODATION

With the completion of the new wing added to the Botanic Gardens building, a portion of the staff was moved from the central office in the city. This is the first step towards maintaining the activities of the two Christchurch Observatory organizations in one area.

INSTRUMENTAL

Apia

Terrestrial Magnetism.—Although some trouble was again experienced with variometer recording clocks, very little record was lost. All clocks, including the spare, were completely overhauled, and inquiries are being made concerning new units. The magnetograph calibration apparatus functioned satisfactorily, although some trouble was experienced with the galvanometer. This is being replaced.

Seismology.—The three component Wiechert seismographs and the Wood-Anderson short-period seismograph were operated continuously. Minor trouble with the synchronous motor driving the Wood-Anderson recorder was rectified. A rectifier unit with a battery as ballast was installed to obtain a constant light source, and proved very effective until a fault developed necessitating its return to Christchurch for repair. During its absence a voltage-regulating unit was used with some success, although frequency variations were not entirely overcome. A vibrator unit for supplying power to activate the motor during power failures is being developed at Christchurch. Similarly, an improved relay system for time-marking records is under construction.

Tides.—The tide-gauge functioned satisfactorily with very little loss of record. This year the zero of the tide-staff was checked against one of the major bench marks of the island, and found to be the same, within the limits of observation, as the less comprehensive check of previous years.

Time Service.—Slight adjustments had to be made to the synchronome clock early in the year, but apart from this all clocks functioned well.

Ionospheric Recording

Rarotonga.—Apart from replacement of minor components, the manual recorder gave satisfactory recording until the latter part of the year. Data received latterly indicate the possibility of a major equipment defect. The A.C. power supply has been brought to the building, but the recorder is still being operated by Diesels pending the improvement of the local power system. A twenty-four hour observing schedule has been maintained since 1st June.

Lincoln.—Minor electrical and mechanical breakdowns caused some loss of record during the year. The 5 kW. Hill diesel was installed, and slight modifications were made to the J.28 recorder so that it could operate on power supplied by the diesel during A.C. supply failure.

Campbell Island.—The equipment was checked by a senior officer of the Observatory during November; this recorder needs replacement at an early date. Recorders at all stations should be replaced by modern automatic equipment to increase the value and quantity of the data obtained.

Experimental Station.—A fluxmeter was installed with the object of recording rapid changes in the earth's magnetic field. Satisfactory operation has not yet been obtained. The manual ionosphere recorder has also been operated as required.

RECORDINGS

The geomagnetic, ionospheric, seismic, cosmic radiation, and meteorological recording programmes have been maintained at all sub-branches. Current geomagnetic data were supplied monthly, as in the past, to the Meteorological Institute, De Bilt, Holland, and the Association of Terrestrial Magnetism, International Union of Geodesy and Geophysics, while ionospheric data have been forwarded monthly to the Radio Research Board, Sydney, and the Central Radio Propagation Laboratory in Washington. Data have also been made available regularly to other organizations on an exchange-of-data basis. Publishing of data relevant to magnetic disturbances in the *Journal of Geophysical Research* has been continued. Arrears of Apia and Christchurch data await publishing. Details of magnetic activity from Apia and Amberley, and ionospheric characteristics recorded at Lincoln, have also been published monthly in the *Cosmic Relations Bulletin* issued by the Radio Research Office, Wellington.

Calibration of the Wiechert seismographs at Apia has been undertaken monthly, while the Wood-Anderson seismometer has been standardized every quarter. Seismological bulletins have been issued quarterly, while fortnightly air letters of preliminary earthquake readings have been despatched to New Zealand observatories as well as to selected ones in America and Australia. The practice of advising the United States Coast and Geodetic Survey of details of strongly recorded shocks has been continued. Instrumental magnitude determinations have been used on strong shocks from the N.–S. direction recorded on the Wood-Anderson.

Ionospheric film measurement at Christchurch was made easier by the development of a film viewer to replace the method of film reading in the darkened projection room.

Data from the Compton Bennett cosmic-ray meter has been forwarded quarterly to the Carnegie Institution of Washington. The 1948 data was analysed to redetermine the barometer coefficient of the ionization chamber.

Nuclear research plates, covered respectively with copper, tin, iron, aluminium, lead, and carbon, were exposed on Mount Herbert for the purpose of investigating the reaction products of cosmic rays with the different absorbing materials. Two packages of plates were also exposed on aircraft up to 30,000 ft. at Ohakea through the co-operation of the R.N.Z.A.F. Two dozen were also taken by air to and from Apia. All have been processed. Developing techniques were improved during the year. A binocular microscope was received towards the end of the year, and a commencement has been made on the detailed examination of plates which have been accumulated since this work was started.

Climatological observations have been maintained at Christchurch, and relevant information forwarded to the Director of Meteorological Services, Wellington.

RESEARCH

Investigations into the relationship between geomagnetic and ionospheric changes associated with solar phenomena are being undertaken, utilizing recordings from Apia, Amberley, and Lincoln. Promising results have been obtained concerning the relationships between solar flares, associated geomagnetic effects, and ionospheric effects on the one hand and the following magnetic storm with radio communication disturbance on the other. The co-operation of the Post and Telegraph Department and the New Zealand Broadcasting Service in supplying immediate information on fade-outs, and of the Director of the Carter Observatory in making available daily relevant solar data, has been obtained

and is helping the research materially. The need for a more satisfactory index of ionospheric activity has been evident for some time, and after much investigation an improved index has been developed.

At Apia a survey of the station's sensitivity to earthquakes in the South-west Pacific was made, and details were obtained of the maximum distances from which shocks of magnitudes 6 to 7½ had been successfully recorded.

GENERAL

The Director visited the Apia sub-observatory on two occasions for supervision and staff instruction purposes. Replacements for Apia have been drawn from the Christchurch organizations, and a roster covering several years has been drawn up so that officers are aware when they will be called on for service there. This will also be valuable in arranging training for their island terms.

In view of the proposed change in siting of the Campbell Island establishment to enable improved meteorological recording to be obtained, an officer visited the island to consider alternative locations for the ionospheric equipment. On the same trip this officer also visited the Australian scientific establishment at Macquarie Island.

As usual, the replacement operators for Rarotonga and Campbell Island received training in their duties, while tuition in ionospheric work was also given to the Post and Telegraph Department operators before their departure to Campbell Island.

GEOPHYSICAL OBSERVATORY, WELLINGTON

Director: Mr. W. M. Jones

Wave Studies.—A wave-recording unit and frequency analyser arrived from the Admiralty in February, 1950. In addition to the analysis of wave records, the analyser can be used for any type of record if converted into the black and white profile required. The wave-recorder is to be installed at Greymouth, and awaits only the laying of 2,000 yards of cable for the sea unit. A programme of study of wave patterns, their relations to weather conditions and to microseismic activity, and the possiblities of swell forecasting will then be initiated. Other wave records are being made at Island Bay, Wellington, by a microbarographic recorder.

Tides and Sea-level Oscillations.—A relation has been established with the age of the moon and the variations of tidal phase differences between Island Bay and Makara. Although these two places are only some ten miles apart, the times of high and low water at Makara vary between two and six hours behind those at Island Bay. The hydrographic survey of H.M.N.Z.S. "Lachlan," to be resumed in Cook Strait in April, will provide additional information on tidal times at different points in the area, and it is intended to intensify this study when the data are available.

In the course of visual observations—made every 15 seconds or 30 seconds—mainly at Island Bay, oscillations of a few inches of level, and of periods intermediate between those of ordinary swell and those of tides, have been detected. One of these, of 4-minutes period, is thought to be a seiche set up in the rock channel. Others, however, of 15 minutes to 30 minutes in period, are considered of more distant origin—possibly from distant storms.

These observations and the wave records are being examined by two methods: firstly, by that of frequency analysis by the Admiralty analyser; and secondly, by the development of correlograms and periodograms by treatment of the data in punched-card machines following a method devised by Mr. I. D. Dick of the Applied Mathematics Laboratory.

Sea Temperatures.—Two surface recording thermographs have arrived. Tests of these, attached to the sides of launches at anchor in Island Bay and Makara, showed a consistent difference of some 3°F. between the two localities. The thermographs will be installed as opportunity offers on naval or other vessels. An insulated water-sampler, with three protected thermometers, has also arrived; it is intended to use this on H.M.N.Z.S. "Lachlan" for deep-water temperature observations. Three bathythermographs are on order from the U.S.A., of which two are expected in May. A programme of surface observations by interested launch or fishing-boat operators, using bucket and thermometer, has been commenced in the Pelorus Sound, Queen Charlotte Sound, and Nugget Point areas. This is expected to give data on temperature variations and distribution which will help to define problems for more detailed study.

Microseisms.—Analysis of seismograph records of microseisms by the frequency analyser should greatly facilitate the study of the relations of microseisms to weather conditions and to waves. Methods of conversion of the records to the form required are being developed.

Other Investigations.—Using equipment of the Geological Survey, a few records have been obtained of the ground vibrations caused by surf; these offer, amongst other things, a convenient method of recording surf periods from a shore installation.

A series of observations, made recently at Tongue Point and Makara by Banwell and Olsson of the Dominion Physical Laboratory, showed the possibilities of obtaining information on tidal or other currents by the ground potential differences produced between pairs of electrodes on shore. It is intended to extend this work at other points where the disturbing effects of tram-line currents are less prominent, and sites for tests near Cape Campbell and Greymouth have been selected.

A library of books and periodicals relating to physical oceanography is being accumulated.

GRASSLANDS DIVISION

Acting-Director: Mr. E. A. Madden

STAFF

The Director was in Europe during the year under review attending the Fifth International Grassland Congress in Holland and delivering a series of lectures in the British Isles at the request of the United Kingdom authorities. One senior officer attended a Commonwealth Specialist Agricultural Conference in Australia.

Special research work at substations has not proceeded at the desired rate owing to shortage of professional staff. Technical staff recruitment has also been below requirements.

PLANT-BREEDING

The standard of the pedigree strains of pasture plants already produced is being maintained and improved by further breeding. As improvements are made, nucleus seed stocks are handed over to the Department of Agriculture for further increase under the Government seed certification system. The stage

has now been reached when most of the certified seed of perennial rye-grass, timothy, white clover, Montgomery red clover, and cow-grass, and all Italian and short-rotation rye-grass, is of pedigree origin.

Pasture trials are being continued at Palmerston North, Lincoln, and Gore to compare the performance of pedigree strains with that of the best New Zealand and imported strains.

Preliminary investigations on the possibility of breeding improved strains of other species are being carried out. The variability in New Zealand and imported lines of *Lotus uliginosus* and *L. corniculatus* is being studied. Information is being obtained on the reproductive mechanisms of these species and of strawberry clover as a guide to the most desirable breeding technique to use in any plant-breeding work with them. The study of some 2,000 individual plants of Yorkshire fog selected from a hill-country pasture at Te Awa has shown the extreme variability between plants of this species in such characteristics as vigour, leafiness, rust susceptibility, time of flowering, growth form, and longevity.

To provide information on aspects of plant-breeding techniques with cross-pollinated plants, an experiment has been carried out on a comparison of various systems of progeny testing with *Lolium*. The value of the progeny test by open-pollination in an "increase area," as a method of testing the combining ability of selected plants, was shown.

STRAIN ECOLOGY

Nucleus Seed Production.—For some years nucleus seed of perennial rye-grass, Italian rye-grass, short-rotation rye-grass, white clover, Montgomery red clover, and cow-grass have been produced, and recent additions to these are nucleus timothy and nucleus cocksfoot.

Seed Certification.—The seed certification scheme ensures that the advantages of the nucleus selection work are maintained year after year. The number of plot tests required in the operation of this scheme this year amounted to 9,083, a slight increase on last year's figure of 8,994.

Plant Introduction.—Approximately 100 samples of grasses and legumes have been introduced for trial during the year. These have come from America and Europe, and have been obtained through the plant introduction service of the Botany Division. In the course of the trials extending over a number of years some 700 samples have been grown but only 228 distinct species have been represented. These are being grown at Palmerston North on rich alluvial soil, at Himitangi on sand country, and in wind-eroded hill country in parts of Hawke's Bay and in Poverty Bay. Many of the species introduced do not succeed, but there are a few species which show promise of being useful.

PASTURE ECOLOGY

Trials to Compare Pasture-management Systems.—There has been a drop in production on the complete special-purpose pastures of the farmlet trials owing to loss of red clover through the excessive water of last winter and *sclerotinia* damage. On the other hand, the block using a rotation of summer crops (chou moellier and rape) and special-purpose pastures has produced better than the others owing to a favourable season and the influence of the newly-sown red-clover paddocks, which normally produce well for the first two seasons.

Last year's trial to study the influence of grazing management on clover establishment has emphasized the need to graze fairly closely for the first six months following autumn sowing. Differences in clover content of nearly 300 per cent. were recorded between grazing at 3 in. compared with letting the pasture grow to 9 in. between grazings. The shorter growth favoured clover establishment and spread. A repetition of this trial has been laid down this autumn.

The influence of earthworms on soil structure is still being studied. Results of investigations so far conducted reveal the importance of earthworms in the cycle of pasture growth and soil fertility.

SOIL CONSERVATION AND HILL-COUNTRY PASTURE IMPROVEMENT

Most of the investigations have been carried out in Pohangina County and in the East Coast district, and to a lesser extent at Waiouru, Mangaweka, and Hawke's Bay.

Work at Te Awa (Pohangina County) has been directed towards gully control by attempting to grass the gully floor, following construction of a well-graded surface by bulldozers. This has so far been unsatisfactory because of the time lag between sowing and establishment, during which period heavy rains are likely to occur. A combination of trees and grass is now being tried. Records of sheep weights and grazing days have been kept and botanical changes following oversowing and top-dressing have been recorded. On the Te Awa area good results have been obtained by oversowing and top-dressing. Experiments are under way to determine the relative production on hill-country pastures treated as follows: (*a*) control, no treatment; (*b*) top-dressed with fertilizer; (*c*) oversown with clovers and grasses but no fertilizers; and (*d*) oversown with clovers and grasses and top-dressed with fertilizer.

There are experiments in several districts to ascertain to what extent pastures and pasture plants can assist in soil conservation, and several recent introductions from overseas are included in these trials.

Areas that have been top-dressed from the air are being inspected periodically, put improvement seems to be limited by the lack of responsive clovers.

Recordings of observations and measurements have been continued on the trial plots in inland Taranaki, King-country, East Coast, Hawke's Bay, and Wairarapa. Results generally have been somewhat disappointing, although in certain areas the autumn-sown plots have maintained their superiority, with an establishment of clover varying from 1 to 8 plants per square foot. In the surrounding areas these species are non-existent.

Plots sown in the spring are definitely poorer than those oversown in autumn. In many cases this appears due to unfavourable summer conditions resulting in the death of young plants.

GREENKEEPING RESEARCH

(In conjunction with the New Zealand Golf Association and New Zealand Bowling Council)

Routine maintenance and fertilizer applications on the research area have been carried on throughout the year. Measurement trials of production of herbage under different manurial application are yielding some interesting data, but the trial must continue for several years in order to measure seasonal effects. Work with various chemicals for weed and pest control, including control of earthworms, has been carried out when favourable conditions have been encountered.

Two greenkeeper's conferences were held during the year, and two diplomas in greenkeeping were awarded.

AERODROME ADVISORY SERVICE

Advice has been given to enable aerodrome surfaces throughout New Zealand to be kept in satisfactory condition. Better results may be anticipated now that sulphate of ammonia is more readily available.

LINCOLN SUBSTATION

The new pasture, hay, and dual-purpose cocksfoots, bred at Palmerston North, have proved over four years to yield about 15 per cent. more feed than the Government stock strain.

In cocksfoot, high yield of seed usually means low yield of feed, as in Danish cocksfoot, and this is true of the new strains, which give a rather lower seed-yield than Akaroa though they produce more feed. Fortunately, this slight reduction in seed-yield can be more than made up by the application of sulphate of ammonia, which, in a recently concluded trial, more than doubled the seed-yield. A new trial has been started to test the effects on seed-production of different rates and times of application of manure.

Intensity of grazing greatly influences the proportions of grasses and clovers in the pasture. Studies are in progress to determine more precisely the effect on the composition of the sward of (*a*) continuous grazing, (*b*) grazing when the grass reaches a height of 4 in., and (*c*) grazing at a height of 10 in.

In addition to the effect of grazing on the pasture, information is required on the effect of animal manure compared with artificial fertilizers. For this, various forms of lime, phosphate, potash, and nitrogen are being applied at rates equal to those found in the dung and urine from sheep grazing the trial area. Total yields and dry-matter yields will be measured, and botanical analyses made.

A single-plant area has been established of breeding material of perennial, Italian, and short-rotation rye-grass, cocksfoot, white clover, Montgomery red clover, and broad red clover.

Numerous other manurial and management trials are in progress, and the turf advisory service to sports bodies and aerodromes is being continued.

OTHER SUBSTATIONS

Pasture-management trials are now operating fully on plots laid down in autumn, 1949.

Herbage-production from strains of grasses and clovers show that no strains tested are superior to those selected at Palmerston North.

Progeny testing of breeding-material has not proceeded far enough to show whether the behaviour of the various progenies at Gore is similar to their behaviour at Palmerston North.

The effect of clovers on the grass of the sward is being studied, and indications are that red clover is not as efficient a nitrogen provider as white clover.

Areas have been sown in pasture to determine the influence on both pasture and stock of various systems of pasture managements. Persistency of both perennial and short-rotation rye-grasses is being studied in these trials.

POLLEN FOR MEDICAL INSTITUTIONS

A total of 1,009 grams of grass pollens has been supplied this season to medical institutions for further work on hay-fever.

CLIMATOLOGY

The climatological station set up at Palmerston North and the rain-gauges at Te Awa are attended to daily, and records are forwarded to the Meteorological Section of the Air Department.

GENERAL

Numerous visitors from both New Zealand and overseas have inspected the research areas, where they displayed keen interest in the work.

Twenty-two papers dealing with grassland research have been read, published, or submitted for publication during the year.

INFORMATION BUREAU

Officer in Charge: Mr. N. A. Marris

PUBLICATIONS

Journal of Science and Technology.—The number of papers being received for publication still continues to increase. Unfortunately, the *Journal* is still in arrears, and it is now not anticipated that it will be up to date until 1951.

Bulletins.—In the Department's Bulletin Series, No. 96—"Rhythms of Nematode Parasitism of Sheep," by J. H. Tetley—was issued during the year, while the following manuscripts are in the process of being printed: "The Introduced Mammals of New Zealand," by K. A. Wodzicki; "Poisonous Plants in New Zealand," by H. E. Connor; and "Catalogue of the Diptera of the New Zealand Sub-region," by D. Miller. The maps for the proposed bulletin on "Soil of Whangarei County" are being printed.

The following Geological Bulletins are also in course of being printed: "The Greymouth Coalfield," by M. Gage; "Limestone Resources of Southland," by R. Willett; "Geology between Bruce Bay and Haast River," by H. Wellman; and (as a Palæontological Bulletin) "Lower Pliocene Mollusca," by C. R. Laws.

The Department is also publishing a series of bulletins dealing with the research work carried out at the Auckland and Campbell Islands in the years 1941 to 1945. The numbers of the series printed during the past year were "New Sub-Antarctic Collembola," by J. T. Salmon; and "The Royal Albatross," by J. H. Sorensen, while others are in the process of being printed.

In the series of Information Bulletins, No. 2, "Tomato Diseases and Pests," and No. 3, "Wheat Diseases and Insect Pests," were published.

The *Industrial Bulletin*, which is published jointly with the Department of Industries and Commerce, was continued, contributions also being received from the Department of Health, the Department of Labour and Employment, and the New Zealand Standards Institute.

Miscellaneous Publications.—Other publications issued by the Bureau were the first two numbers of the Grasslands Bulletin series, and Nos. 110 and 111 of the Seismological Bulletins. The Bureau also assisted with the publication of the two-monthly *Paint Review*, the *Agronomy Review*, and the Agronomy Division's *Guide*.

LIBRARY

With the steadily increasing output of scientific publications, the work of the library has been handicapped during the greater part of the year by shortages of staff and inadequate accommodation. Service to the branches of the Department has nevertheless been maintained, and the libraries of three of the branches engaged in plant research have been created or organized and strengthened during the year.

TECHNICAL INFORMATION SECTION

This Section at Head Office dealt with 770 major inquiries (this number does not include those answered by the Industrial Liaison Officers at Auckland, Christchurch, and Dunedin). The bulk of the inquiries originated from manufacturers, and shows that the service continues to be appreciated by industry. In answering inquiries, the Section keeps in close touch with the professional staff and, where necessary, with the Scientific Liaison Officers in London, Washington, and Melbourne.

Abstracts.—Over 400 abstracts of articles in New Zealand and overseas journals were prepared during the year. The majority of these were for inclusion in the *Industrial Bulletin.* Photostatic copies of 500 original articles were supplied to inquirers following publication of abstracts.

Translations.—Scientific papers published in foreign journals were translated, as required, from French, German, Spanish, and Portuguese. Certain articles published in the *Industrial Bulletin* were translated directly in abstract form from French and German originals.

PUBLIC RELATIONS

General Publicity.—The regular issue of general press releases on the work of the various branches or special aspects of this work has continued. Other press releases on matters of immediate news value have been sent to the Press Association, the Wellington daily newspapers, and the Broadcasting Service as they arose. Good coverage has been obtained throughout New Zealand, and these articles have been generally well received. When application has been made for exclusive articles, interviews have been arranged between senior officers and press representatives, or specially written articles have been supplied. General information on the work of the Department has been increasingly sought by the press, and a considerable number of inquiries on specific subjects has been dealt with.

Films.—Two technical films were presented to the Department by the United Kingdom D.S.I.R., and these were lent to interested organizations throughout New Zealand. Films were also borrowed from the Australian Commonwealth Scientific and Industrial Research Organization and shown to the staffs of branches and other Government Departments and outside organizations. Difficulties of arranging screening accommodation, lack of projectors, and absence of full information on suitable films have yet to be overcome, but as far as practicable the screening of films that furthered the work of the Department was undertaken.

Broadcasting.—During the year a series of six broadcast talks on the work of the Department was arranged and given by members of the staff, and other individual short talks were broadcast.

Displays.—Exhibits, as part of the Government court, were shown at the Christchurch Industries Fair, the Hamilton Industries Fair, and the Auckland Trade Exhibition, and an exhibit, diagrammatically showing the time service of the Seismological Observatory, was provided by the Department for the exhibition at Auckland organized by the Horological Institute. Other displays have been organized by Branches.

Press Clippings.—Approximately 2,500 newspaper and magazine cuttings of possible interest to the Department were examined, and those of particular interest to the staff were circulated.

PHOTOGRAPHIC SECTION

During the past year the range of work undertaken for the Branches by this Section has increased. Photographic albums were made and dispatched to the Department's Scientific Liaison Officers overseas. Albums on *Phormium tenax* are in the course of preparation. These show all phases of work from planting to the cutting of the flax.

The field photographer has made several visits out of Wellington, including trips to the Awatere Valley, Central Otago, Havelock North, Moutoa, Lincoln, &c., in connection with the work of the Branches.

The library of 35 mm. colour slides is being built up and is proving of considerable value for work where colour is advisable.

Other services to Branches include the preparation of gestefilms, photocopy, lantern-slides, and general development and printing work.

MAGNETIC SURVEY

Director: Mr. H. F. Baird

Customary observational and recording programmes in geomagnetism and seismology were fully maintained. The three sets of magnetographs recorded continuously at Amberley, and field observations in different parts of New Zealand have been continued.

MAGNETIC SURVEY RESULTS

A navigation chart for the whole of New Zealand was prepared, and for the first time was published in the "New Zealand Nautical Almanac and Tide Tables." For inclusion in the "New Zealand Air Pilot and Flight Information Manual," navigation charts from the equator to latitude 60° S., between longitudes 150° E. and 150° W., were prepared. The manuscript, tables, and charts, in final form, for all those magnetic observations from May, 1941, to December, 1948, at 219 points ranging from Spirits Bay to Campbell Island and across to Chatham Islands have been submitted for publication. The publication of these magnetic resurvey data, as at epoch 1st July, 1945, summarizes a difficult task whose results —when related to the only other magnetic survey of the same area, at epoch 1903·5—give a considerable amount of new information to navigators, cartographers, surveyors, engineers, geologists, and geophysicists. Through the Royal Navy, the Hydrographic Institute of Hamburg received results from Dominion Magnetic Survey for plotting modern navigation charts of the earth. More recently the United States Coast and Geodetic Survey, for American and British charts of later date, used photostat copies of charts prepared from our resurvey data. Reoccupation of some twenty stations, in slightly overlapping groups year by year throughout New Zealand, has now been proved necessary because the rate of change of components of the earth's magnetic field, with locality, is so variable as to be a matter of first importance to navigators and geophysicists.

The International Union of Geodesy and Geophysics sent special instruments by air from Copenhagen so that the instruments at Amberley could be checked on international standard. The check was highly satisfactory.

An air-borne magnetometer was received from England, and was checked by the Dominion Physical Laboratory. In co-operation with the R.N.Z.A.F., it is now being fitted to an aeroplane. Initial steps have been taken, in conjunction with the Geological Survey, to get land-based fixes for using the airborne magnetometer over the thermal region of the North Island in quest of a geothermal source for generation of electrical supply. Arrangements have been made so that, if necessary, the airborne magnetometer when flown over the sea can supplement the off-shore work of H.M.N.Z.S. "Lachlan."

Royal N.Z. Navy ships have reported on the condition of old magnetic stations on various tropical islands north of New Zealand from where this branch will occasionally need to make observations to keep basic documents for the "New Zealand Air Pilot and Flight Information Manual" accurate. The network of those old stations has practically disappeared, so there is a need for future replacement work.

SEISMOLOGY

Bulletins of earthquake records have been sent weekly by air mail to the U.S.A., Strassbourg, Trieste, Rome, and Apia, and monthly by surface post more widely. In return, similar bulletins are received.

The instruments were operated once more in the cellar near to the Observatory. Some progress has been made in modifying them to conform with suggestions of Dr. B. Gutenberg, who visited Christchurch as a delegate from the U.S.A. to the Seventh Pacific Science Congress in 1949. Some evidence of minor artificial disturbance, presumably due to the recent increase in the number of heavy industries in or near the city, has been found.

One shock at sea east of Christchurch called for a visit to Banks Peninsula because "tidal waves" were reported, but it was found that the exceptionally large sea waves were caused by a gale that was blowing at the time of the earthquake.

BUILDINGS

Some damage by gale was done to the magnetic pavilions at Amberley where the continuous photographic recording of base-lines for the whole of the Dominion magnetic survey takes place. An extension to the office in the Christchurch Botanic Gardens, as founded in 1901, has been completed.

OCCUPATIONAL PSYCHOLOGY RESEARCH SECTION

Officer in Charge: Mr. D. Straker

The main functions of the Section are to determine the applicability under New Zealand conditions of the findings of psychologists working in the occupational field overseas, to carry out supporting researches, and to assist in the spread of knowledge about techniques of selection, training, supervision, and other aspects of personnel management. Service to individual employers is normally provided through the Personnel Advisory Division of the Department of Labour and Employment, but the Section carries out some servicing work in order that researches may be related to realistic situations, and to facilitate the collection of data comparable to those obtained from laboratory experimentation by other scientific disciplines.

RESEARCH

Management Problems.—As a means of gaining acquaintance with New Zealand occupations, the officer in charge has visited a number of workplaces throughout the Dominion. Personnel aspects of management in firms of moderate size were discussed with a view to the publication of a guide to modern personnel practices adapted to New Zealand industry. Particular attention is being paid to the attitudes of management and operatives towards works councils and similar advisory bodies; and an analysis is being made of the functions of councils that have become firmly established and of the reasons that have led to the discontinuance of others. It is intended that the guide should cover methods of interviewing and assessment, arrangements for introducing new employees to the firm, and selection and training of operatives for promotion to supervisory work.

Scientific Research Workers.—A survey is in progress aimed at evolving improved methods in the recruitment, selection, and training of scientific research workers. It has become apparent that more well-balanced information on careers should be made available to undergraduates specializing in science, that selection committees require more information about selection methods that have been developed overseas, and that even closer liaison between University and employer is desirable.

Apprenticeships.—Preliminary steps have been taken to obtain data about the levels of attainment, intelligence, and special aptitudes needed for success in various skilled trades. This investigation will extend over several years in order that sufficient case studies of unsuccessful apprentices may be collected. It should provide information of value to vocational guidance officers, careers teachers, Apprenticeship Committees, and prospective employers of apprentices.

SERVICE

National Service Recruits.—At the request of the Navy and Air Departments it has been arranged to apply a common aptitude test, made available by the Admiralty, to men registering under the Military Training Act, 1949, who express a preference for the Navy or Air Force, and the same test will be applied by the Army Department to all Army national service recruits. Personal history sheets, similar to the one already in use by the Army, have been designed for the other two Services. A five-day course, in the running of which the Army's Staff Officer for Personnel Selection took part, was held to instruct Naval and Air Force recruiting officers in the most up-to-date techniques of interviewing and aptitude testing. As a result of these arrangements, the recent overseas developments in methods of selecting and allocating recruits have been made available to the New Zealand Armed Forces, while the groundwork has been prepared for nation-wide researches which it is expected will be of benefit to industry and to education.

Air Department.—The Section has continued to provide a member of the Aircrew Selection Board examining applicants for aircrew training in the R.N.Z.A.F. This year assistance has also been given with the selection of candidates for the Territorial Air Force. All applicants interviewed were also given a series of aptitude tests.

Navy Department.—In conjunction with Service officers, procedures employed by Selection Boards concerned with the lower-deck entry were remoulded to include more objective aptitude tests and a more comprehensive interview.

LIAISON, EDUCATION, AND INFORMATION

Arrangements for the exchange of information have been made with the Senior Psychologist to the Admiralty, and with the Director of the National Institute for Personnel Research of the South African Council for Scientific and Industrial Research.

With the approval of the University faculties, discussions have taken place with a number of students about choice of subjects for theses in applied psychology. This development is welcomed, and it is hoped to extend it by providing facilities for senior students to assist with the investigation of problems as they arise in industry.

Several lectures on personnel management problems have been given to audiences of managers and foremen. The substance of these talks is appearing in a series of articles in the *Industrial Bulletin.*

Information has been given to various inquirers referred by the Departments of Health and Labour and Employment on matters such as plant layout, the design of equipment, the use of music, and merit-assessment procedures.

PLANT CHEMISTRY LABORATORY

Director: Dr. J. Melville

SEED RESEARCH

The use of a staining technique has made possible the determination in twenty-four hours of germinating capacity of rye-grass seed with a high degree of reliability as against the standard methods of from nine to twelve days.

A record has been made of the changes in seed weight and moisture content during development. Results from the first two seasons show that three stages may be distinguished: the first is one of rapid growth with a constant ratio of water to dry matter; in the second the rate of dry-matter increase is accelerated while the water content per seed remains nearly constant; and in the third there is a stage of desiccation when dry-matter content remains stable and water content rapidly decreases. The durations of the three stages are approximately eleven, seventeen, and ten days respectively for perennial rye-grass, and eleven, nine, and five days for white clover.

With both rye-grass and white clover the earliest stage at which viable seed was harvested was eleven days after flowering, when the dry weight was approximately 40 per cent. of the weight at maturity. The percentage of hard seeds in white clover increased up to full maturity when 98 per cent. of viable seeds were impermeable.

The work is designed to show the effects of the stage of maturity of the seed at the time of cutting upon the yield and quality of the seed. As clover and grass-seed crops mature, the more advanced portion tends to be lost through shattering while the more backward portion is still increasing in weight. Hence the time of harvest must always be a compromise in which the risk through loss by shattering is balanced against that of a high proportion of immature seeds. Those investigations should indicate what improvements in yield and seed quality can be expected by changing the time and methods of harvesting.

THE FACTORS GOVERNING GERMINATION AND ESTABLISHMENT OF CLOVERS

Temperature coefficients of the speed of germination of white, red, and subterranean clovers show similar maximum values. For white clover this occurs between 10° and 25°C., for red between 10° and 20°C., and for subterranean clover over a still smaller range.

A study is being made of the interactions of temperature, light, and nutrient supply on growth of seedlings up to six weeks. Two points emerge from the investigations to date—viz., rate of growth is increased by nutrient supply at a very early stage, and the size of clover seedlings is directly proportional to weight of seed up to the six-week stage. This latter observation was made under low light intensities and may not apply under other light conditions.

THE NITROGEN CYCLE IN PASTURES

Further work has been done on the rate of breakdown of urea in herbivorous urine when voided on the soil. The rate of hydrolysis of urea applied as urine may be up to five times as rapid as that of urea in pure solution. Marked stimulation of urea breakdown by other urinary constituents applied singly is given only by hippuric acid, although a mixture of all known nitrogenous constituents causes a greatly enhanced rate of hydrolysis over hippuric acid alone.

In preliminary experiments, washed suspensions of mixed soil bacteria caused no hydrolysis of urea, while sterilized soil was also quite inactive. Unsterilized soil, and sterilized soil to which suspension was added, both showed high activity.

Next to urea, the amino acid fraction is quantitatively the most important. The urine of sheep is different from that of other species in that it appears to contain only one amino acid—viz., glycine.

NITROGEN METABOLISM OF PASTURE PLANTS

Investigation of the effect of fertilization with nitrate, ammonia, and urea has been continued with the object of determining the way in which they are transformed into leaf proteins. This involves a study of the simple organic compounds that are the first products of nitrogen metabolism. Improved analytical methods show differences in the proportions of amides and amino acids (the building blocks of proteins) with different nitrogen fertilization, while there is also a different pattern between plants with low and high supplies of lime, phosphate, and potash.

The position of urea in plant metabolism has been further investigated, but considerable technical difficulties have still to be overcome. Yeast is also being used as an alternative biological material and one whose metabolism is simplified through absence of the photosynthetic apparatus.

MICROBIOLOGY

Owing to the resignation of a member of the staff, work on the antagonistic properties of the higher wood-rotting fungi has been temporarily discontinued, but the results so far obtained are being prepared for publication.

The study of that important group of soil organisms, the Actinomycetes, is being continued both with regard to antibiotic properties and systematics. A promising organism was investigated in greater detail, and it was shown that its antagonistic properties were due to production of an anthraquinone type of pigment.

The atmospheric mould survey being conducted at the request of the Medical Research Council will be completed in July, 1950, when two years' results will have been obtained. A total of 20,000 mould colonies, representing 34 genera, have been identified, and 41 dry spore preparations have been made for skin testing.

The successful establishment of clovers is a necessary prerequisite for high-production grassland farming, and there are large areas in New Zealand where development is retarded because of failure of clovers to establish. One of the obvious reasons is that clovers in these problem areas are not being infected by nodule bacteria, which are effective nitrogen-fixers, and techniques have been worked out to determine whether failure to nodulate is a cause of poor establishment. The indications are that infection by bacteria is not generally a limiting factor, and that experimentation should be directed to improving the nutritive status of the soil.

THE MINERAL CYCLE IN PASTURES

The trial conducted by Grasslands Division at Palmerston North on the effect of clovers in the sward will terminate this year so far as detailed analyses are concerned. Exactly similar trials have been established at Gore and Lincoln, and chemical analyses are being conducted in the light of our experience in Palmerston North. Particular attention is being paid to the turnover of phosphate, since in the Palmerston North trial there was no phosphate response on the mixed pasture plots to which animal droppings were returned.

FORAGE CROPS AND VEGETABLES

Over a considerable period of the year the main source of vitamin C in the New Zealand dietary comes from potatoes. A pilot trial on the rate of loss of vitamin C in stored potatoes was undertaken last year, and a full-scale trial in which the effect of variety and of locality will be determined is being undertaken this year.

GENERAL

Dr. B. W. Doak was a New Zealand delegate to the Fifth International Grasslands Conference in Holland, and visited many scientific institutions in Great Britain, the United States, and Canada.

Dr. J. Melville was one of the New Zealand delegates to the Specialist Agricultural Conference in Australia.

PLANT DISEASES DIVISION

Director: Dr. G. H. Cunningham

PLANT DISEASE AND PEST INVESTIGATIONS

Tomato Leaf-mould.—In collaboration with the Department of Agriculture, trials with the Improved Bay State tomato variety, which had previously shown resistance to leaf-mould under experimental conditions, were laid down in the four main glasshouse tomato-growing areas; results have confirmed its resistance to leaf-mould, and have shown that yield and quality are equal to or better than those of the standard glasshouse varieties grown in New Zealand. Approximately 15 lb. of seed of this variety has been produced for distribution to commercial growers.

Tomato-canker.—Investigations to ascertain the effect of method of seed extraction on the seed carriage of tomato-canker showed that acid extraction with 1·6 per cent. hydrochloric acid destroyed tomato-canker organisms carried on the seed. The alkaline method of extraction, using 10 per cent. washing-soda, did not destroy the organisms.

In experiments on control of tomato-canker on dry seed samples it was shown that seed-carried infection could be eliminated by treatment for twenty-four hours with 5–8 per cent. hydrochloric acid or 1 in 2,000 acidulated mercuric chloride without loss of germinating capacity.

Potato Virus Diseases.—In a survey of certified seed potatoes for masked virus infection the eight varieties tested all showed some infection with potato virus X, while three varieties—Aucklander Short Top, Aucklander Tall Top and Dakota—showed some infection with potato virus Y.

Potato Fungus Diseases.—A survey of potato crops throughout New Zealand showed that the following diseases were of importance: late-blight in Auckland, Nelson, and Dunedin; sclerotinia-disease in Auckland and Dunedin; corticium-disease in Palmerston North; and verticillium-wilt in Christchurch and Dunedin.

Flax-rust of Linen Flax and Linseed.—A further series of 21 linseed and linen-flax varieties was tested for resistance to rust. The varieties Ottawa 770B (C.I. 355). Argentine Selection (C.I. 462), B5128, Tammes Pale Blue (C.I. 333–1) and Marye (C.I. 112) were found to be highly resistant. The high resistance of Sheyenne, the Russian varieties Stakhanovetz (D. 83 and 806/3), Cascade, Wada, and Argentine II was confirmed in further tests.

Identification of flax-rust races has been continued, and the work is still in progress, approximately 50 collections of rust having been tested on differentiating varieties. To secure information on the overwintering of flax-rust, a survey of 38 linen-flax areas in South Canterbury was carried out during October, 1949. Volunteer plants were found in 17 areas, and flax-rust infection was found on plants in five of these areas.

A survey of 95 linseed crops carried out during February, 1950, in Canterbury, Otago, and Southland, showed that flax-rust did not cause major losses during the past season. Of the 74 crops showing infection, the disease was severe in 7, moderate in 8, slight in 16, and the remaining 43 showed only a trace of disease. Infection was found in a few Golden Viking crops, but all Sheyenne crops remained free from the disease.

Browning of Linseed and Linen Flax.—During a survey of linseed crops it was found that browning was confined to South Otago and Southland. Of 14 crops infected, 4 showed moderate and 3 slight infection, and the remaining 7 showed only a trace of the disease.

Pasmo of Linseed and Linen Flax.—This disease was largely confined to Mid and South Canterbury, but its incidence was greater than in the previous season. Thirty-five crops were infected, of which 8 were severe, 10 moderate, 1 slight, and 16 showed a trace of infection.

Root-rot of Peas.—Glasshouse and field trials to ascertain the possibility of controlling root-rot by application of fungicidal seed dressings showed that in heavily-infected soil none of eight materials tested gave adequate protection against this disease.

Pea-wilt.—The causal organism, *Fusarium orthoceras* v. *pisi*, of pea-wilt in New Zealand has been identified and its pathogenicity established. Field and glasshouse resistance trials have shown that of the varieties grown in the Dominion 10 garden-pea and four field-pea varieties are resistant.

Collar-rot of Peas.—The search for pea varieties resistant to collar-rot has been continued, but a further 10 varieties tested were all susceptible.

Stem-blight of Peas.—To ascertain the susceptibility of the common pea varieties to stem-blight, a field trial involving 29 varieties was laid down. It was shown that 8 varieties were highly susceptible, 14 moderately susceptible, and 7 slightly susceptible.

Field Survey of Pea Diseases.—To determine the relative importance of the different pea diseases, a survey of 121 crops in the Auckland, Marlborough, and Canterbury districts was carried out in November–December, 1949. The following is a summary of this survey: Collar-rot—67 crops infected; 27 severe, 8 moderate, 14 slight, 18 trace; losses in severely infected areas ranged from 25 to 75 per cent. Pea-wilt—20 crops infected; 11 severe, 5 moderate, 2 slight, 2 trace; the disease occurred in all districts, but was most severe in Canterbury. Downy-mildew—50 crops infected; 1 moderate, 49 slight; the disease was widespread in all districts. Septoria-blotch—16 crops infected; 3 severe, 13 slight; the disease occurred mainly in the Auckland district. Foot-rot—1 crop in the Auckland district showed severe infection. Powdery-mildew, stem-blight, pea-mosaic, and spotted-wilt occurred on odd plants in a few crops but were of minor importance.

Plum-mosaic.—In collaboration with Fruit Research Station, work on this stone-fruit virus disease has been continued, and it has been found that the disease is widespread in New Zealand. Preliminary investigations suggest that the disease can be eliminated from nurseries by rogueing infected stocks and by the selection of budwood from healthy trees.

Verticillium-wilt of Stone-fruit.—*Verticillium dahliae* has been isolated from peaches in Hawke's Bay and Central Otago, and from plums in Hawke's Bay. This is the first record of the disease on these hosts in New Zealand.

Bacterial Spot of Plums.—In a search for a bacteriocide less toxic to plums than Bordeaux mixture, a number of therapeutants have been tested, and of these Shirlan and Zerlate did not cause injury to plum foliage, but their efficiency in controlling bacterial-spot has not yet been ascertained.

Fireblight.—In recent years blossom infection of apples with fireblight has become a serious problem in some districts. Preliminary experiments have been carried out to ascertain whether it would be possible to apply Bordeaux mixture at blossoming without causing undue russeting of fruit. Low concentrations ($\frac{1}{2}$–1–100 and 2–4–100) applied at open cluster and full bloom caused negligible russeting on Granny Smith and Dunn varieties, and slight damage on Sturmer. Marked russeting followed petal-fall applications, and 6–8–100 caused excessive damage under all conditions of application. Bordeaux mixture applied to fireblight-infected cider-apple varieties during blossoming gave some control of blossom infection.

Cat-facing of Peaches by Capsid Bugs.—Investigations at Warkworth and Oratia have shown that a disfigurement of Paragon peaches similar to a condition known as cat-face in the United States of America was caused by an unidentified Capsid bug.

Bacterial Soft-rots.—In experiments on control it was shown that soft-rot of carrots could be satisfactorily controlled by dipping roots in Bordeaux mixture, Perenox, Cuprox, Copper Sandoz, or Zeolite.

Lettuce-mosaic.—Thirty-three lines of lettuce seed were tested for the presence of seed-carried lettuce-mosaic infection. Only six lines were found to be free from virus, and infection in the remaining 27 lines varied from 0·6 to 9·4 per cent.

Cucumber-mosaic.—Celery and anemone are recorded as new hosts of cucumber-mosaic in New Zealand, and it has also been shown that the so-called woodiness disease of passionfruit is caused by this virus.

Tomato spotted-wilt.—This virus has been found occurring naturally on sweet-peas. This is a new host for spotted-wilt in New Zealand.

Virus diseases of gladioli.—Gladiolus varieties in commercial plantings and home gardens were found to be infected with two viruses. One of these was identified as cucumber-mosaic virus, the amount of infection varying widely with different plantings. The identity of the second virus, which also infects various leguminous species, has not yet been determined. This legume virus is very widespread in gladioli.

Red-core Root-rot of Strawberries (Phytophthora fragariæ).—Inoculations with this fungus have been carried out on nine varieties of strawberry to test for resistance. Four varieties—namely, Auchincruive Climax, Oberschlesien, Ettesburg, and Chapman's Seedling—proved resistant. Heat treatment of infected plants failed to control the disease without killing the plants.

Cypress Canker.—Both wound and surface inoculation of young Lawson's Cypress trees with *Coryneum cardinale* isolated from infected nursery trees caused severe gummosis. Nine months after inoculation, cankers encircled the trunk and caused death of branches above points of inoculation.

Crown-gall.—In further experiments on the control of this disease it was found that galls on marigold and peach seedlings could be destroyed by application of elgetol, iodine, or clove-oil.

Green-vegetable Bug.—During the past season this insect was found for the first time in the vicinity of Auckland City. It has also appeared at Gisborne and Coromandel. Therapeutant control is being investigated.

THERAPEUTANT TESTING

Glasshouse Tests

Established techniques of bio-assay of fungicides, using pot plants in the glasshouse, have been extended to include assays under conditions of artificial rain. Using late-blight on tomato as the indicator disease and Bordeaux mixture as the standard fungicide, the artificial-rain technique has shown: (1) various copper zeolites have high fungicidal values and show resistance to weathering; (2) copper oxychlorides show marked reduction in efficiency through weathering; (3) use of adhesives such as polyethylene polysulphide give marked improvement in weathering properties of copper fungicides; and (4) none of the materials tested performed at levels equal to those of Bordeaux mixture.

Various organic compounds have been compared with colloidal sulphur, using bean-rust (*uromyces fabae*) as the indicator disease. Tetramethylthiuram disulphide showed very high fungicidal properties, but because of instability or poor adhesion failed under conditions of artificial rain.

Tests with two grades of winter-oil emulsion differing in percentage content of paraffinic hydrocarbons showed that the grade with the higher content possessed the better ovicidal properties. This result was confirmed in field trials.

Orchard Trials

(*a*) *Fungicides: Control of Brown-rot of Peaches.*—Best results were secured with dichloronaphthoquinone. Applications at blossoming of 1 lb. to 2 lb. to 100 gallons increased crop yield, while pre-harvest sprays not only protected fruit up to the picking stage but resulted in less disease development in storage. On Golden Queen, and to a lesser extent on Paragon, pre-harvest sprays caused grey blemishes on the skin.

(*b*) *Fungicides: Control of Black-spot of Apples.*—Sprays based on phenyl mercury ammonium lactate and phenyl mercury chloride gave better control and caused less foliage injury than the standard sulphur sprays. Ferric dimethyldithiocarbamate and tetramethylthiuram disulphide gave control equal to or better than standard spray; they were slightly less efficient than the mercury sprays but caused less foliage damage. With the above four test materials, appearance of fruit was better than that from standard sprays, except in one case where mercury sprays retarded development of fruit colour.

(*c*) *Fungicides: Control Brown-spot and Grease-spot of Passionfruit.*—Further trials on control of brown-spot and grease-spot of passionfruit have shown that Cuprox at 3 lb. to 5 lb. per 100 gallons is less efficient than Bordeaux mixture (3–4–50). Cuprox caused considerable damage to vines, retarding growth and reducing yield of fruit.

Insecticides.—Trials with dichlorodiethyldichlorethane (DDD) on apples have shown it to give highly effective control of leaf-roller. Treatments applied in the early summer have been shown to be of major importance in control of this pest. Use of DDD has given a marked increase in woolly-aphis populations as compared with DDT, observations suggesting that use of the former had resulted in a greater reduction in the population of the parasite *Aphelinus mali.*

Gamma isomer of benzene hexachloride (BHC) has given outstanding control of woolly-aphis. Winter applications on apples of wettable powders at dilutions equivalent to 5 oz. to 10 oz. gamma isomer to 100 gallons have kept trees virtually clean for the whole summer. Applications during the summer of 4 oz. gamma isomer to 100 gallons have also given control, but in all cases tainting of fruit occurred. Where, in place of the crude benzene hexachloride used in the above trials, 95 per cent. pure gamma isomer has been employed in preparing sprays, tainting of fruit appears to be eliminated.

In experiments for control of red-mite, Selocide, Arathane, parathion and tetraethyl pyrophosphate (TEP) have been compared as summer sprays. Selocide has given highly efficient results. Both Arathane and parathion applied immediately after the blossom period gave control up to mid-summer, after which severe infestations developed. TEP killed adult and nymph stages, but re-infestation rapidly developed.

Vegetable Field Trials

Fungicides.—Various fungicides have been tested for control of late-blight on tomatoes. Treatments with copper oxychloride plus the adhesive polyethylene polysulphide gave better control than copper oxychloride alone. Bordeaux mixture still remains the most effective fungicide. On beans for control of

halo-blight, Bordeaux mixture and copper oxychloride were both superior to the other fungicides that included ferric and zinc dimethyldithiocarbamate, dichloronaphthoquinone and tetramethylthiuram disulphide.

Insecticides.—DDD has again proved superior to DDT for control of corn earworm and looper caterpillar on tomatoes and looper caterpillar on beans. On beans, TEP proved highly efficient for control not only of mites, but also of looper caterpillars and green-vegetable bugs.

TIMBER-PRESERVATION INVESTIGATIONS

Entomological Investigations

Effect of Timber on Egg-laying of Anobium punctatum.—During toxicity testing of preservative materials against *Anobium* using a wide range of timbers, it has been found that there is a considerable variation in numbers of eggs laid on different blocks, for under identical conditions the number of eggs laid ranged from two to several hundred eggs per block. Variation occurs within all timber species, and it has been shown that it is not due to presence or absence of egg-laying sites. Removal from the wood of ether or water extractives does not influence egg-laying. For full-scale toxicity testing against this insect it will be necessary to find some means of obtaining eggs on all test blocks.

Nutrition of Anobium.—Investigation of the nutrition of *Anobium* disclosed that larvæ digest 20 per cent. to 25 per cent. of wood eaten, and that little if any pentose fraction is digested.

Ambeodontus tristis.—Successful egg-laying and establishment of *Ambeodontus tristis* were obtained in the 1949 flight season. Marked differences in larval growth rate were found to occur in different timbers, and some evidence obtained that the rate of growth was related to nitrogen content of the wood.

Mycological Investigations

Laboratory tests are in progress to determine if toxicity of preservatives against wood-destroying fungi is affected by specific gravity of test blocks. Without this information it is not possible to compare results of tests in which retention of preservatives is expressed as weight of material per volume of wood with those in which it is expressed weight to weight on oven-dry basis.

A test of preservatives for mine timbers was installed in the Glen Massey State Colliery during the year.

Preservative Treatment

An investigation on the impregnation of green tawa by diffusion treatment with boric acid was carried out. It was found that within treatment times of one to sixteen hours and solution concentrations of 1 per cent. to 4 per cent. the loading can be calculated, provided treatment time and concentration are known.

Adequate loadings, distributed evenly throughout the wood, of boric acid for prevention of insect attack were obtained in 1 in. boards with treatments of one hour in 4-per-cent. solutions at 83°C., provided treated timber was held under conditions of restricted drying for two weeks after treatment.

MISCELLANEOUS

Legume Culture.—Lucerne culture for 362,000 lb. seed has been sent to 2,757 growers. This represents an increase of 13 per cent. in quantity of culture and 9 per cent. in number of growers over the previous highest figures (1948–49). A few cultures for white clover, subterranean clover, and soya-bean have been distributed.

Factors governing growth of clovers in glasshouse have been investigated and trials on relative efficiency of clover-nodule strains are now in progress. A few field trials, under supervision of Extension Division, Department of Agriculture, are being carried out.

Yellow-leaf of Phormium Flax.—Field investigations have been carried out at Moutoa Estate, Bay of Plenty, Wairarapa, and North Auckland. In all cases observations were made on diseased and healthy flax to determine more exactly symptoms of the disease, particularly in the early stages. Approximately 1,000 isolations have been made from diseased flax roots, but as yet there is no indication that any one or more fungi or bacteria are the direct cause of yellow-leaf. Pathogenicity tests with the most consistent or possibly pathogenic fungi have yielded negative results. Other tests are in progress. A mechanical transmission trial has been set up at Moutoa on highly susceptible flax seedlings to test possibility of virus infection. Axillary bud and root grafts for possible virus transmissions have been attempted.

Other diseases of phormium, often closely associated with yellow-leaf, have been investigated. These are summarized as follows: *Gloeosporium* sp. causing seedling blight in glasshouse, and central shoot-rot hastening complete collapse of yellow-leaf-infected plants; two species of *Fusarium* causing central shoot-rot, scape damage, and large leaf lesions; and soft-rotting bacteria associated with above. Inoculations with above organisms are at present in progress.

Fruit-fly and Fruit Imported from South Africa.—A report on the citrus investigation carried out in South Africa in 1948 was prepared and circulated to interested people. As a follow-up to this an endeavour is being made to arrange experimental shipments of oranges and grapes under cold storage from South Africa to New Zealand this season, and it is hoped the data obtained will allow experimental shipments in 1951. The co-operation of South African authorities in this work is being sought.

European Wasp.—Work on the European wasp is being carried out mainly in the vicinity of Hamilton. It has been shown that the application of DDT to such trees as oaks, the aphis honey-dew on which attracts large numbers of queen wasps, is not a feasible method of control owing to adverse effect on honey bees, which are also attracted by the honey-dew. Particular attention is being paid to an investigation of the economic importance of the European wasp. The only fruit that appears to be damaged is the home-grown grape, which is frequently left on the vines until it becomes very ripe and soft. Work is being carried out on the biology and distribution of this wasp and on its control by the use of bait traps.

House-fly Control.—Trials with house-flies collected from certain localities in Auckland have shown that strains resistant to DDT have developed. Work with resistant and susceptible strains has shown that the insecticides benzene-hexachloride and chlordane are equally toxic to DDT-resistant and DDT-susceptible flies. Tests indicate, however, that DDT-resistant flies are also somewhat resistant to Compound 497 and DDD. Tests on toxicity of benzene-hexachloride have been commenced. The effective life of residues on glass and painted wooden surfaces is also being determined.

Fabric Pest Investigation.—In testing the moth-proofing efficiency of certain materials some interesting anomalous results were obtained that suggest inhibition of moth-proofing activity of these materials when applied under certain conditions. A test method was devised for assessing moth-proofing efficiency of chemically treated fabrics under standard conditions. Brief observations were made on the ability of clothes-moth and carpet-beetle larvæ to survive without food. Some larvæ of the Australian carpet beetle (*Anthrenocerus australis* (Hope)) survived 335 days without food.

Investigation of Resistance of Plants to Insects.—An investigation of plant resistance to insects has been commenced, the first subjects selected for study being varietal resistance of swedes to aphids and of carrots to aphids and rust-fly.

Mite Investigations.—A special investigation of both the Tetranychid and Eriophyid mites is in progress. The taxonomy, biology, economic importance and control are being studied. Several mites of economic importance have been discovered during the past year.

Specimens for Identification.—During the year approximately 530 specimens were received from Orchard and Fields Instructors of the Department of Agriculture and from farmers and market gardeners for identification of disease and advice on control measures.

Publications.—Twenty-eight technical papers were prepared by the staff and submitted for publication. During the year the bulletin on tomato diseases and pests was published, and a revised "List of Plant Diseases in New Zealand" was completed and submitted for publication. The manuscript of a monograph on the "Aphids of New Zealand" has also been prepared and is awaiting printing.

SEISMOLOGICAL OBSERVATORY

Director: Mr. R. C. Hayes

SEISMOLOGY

Summary of Seismic Activity in New Zealand in 1949.—In 1949 the greatest number of felt earthquakes were recorded in February; and one of the strongest shocks of the year occurred on 10th February, at a depth of 170 km. (105 miles), off the coast of South Taranaki. The highest intensities in this shock affected the Taihape–Wanganui area, and it was perceptible from Tolaga Bay to South Canterbury. Although the remainder of the year was comparatively quiet, a shock of intensity M–M VI occurred in the southern part of the South Island on 27th May; and one of intensity V–VI occurred between Murchison and Hanmer on 28th September. A certain amount of activity persisted in the latter region throughout most of the year. Intensity V was experienced at Karamea on 23rd December. On 27th June a shock in the White Island region occurred at a depth of 330 km. (205 miles), and this depth is second only to that of a shock in the same region on 27th June, 1942, at a depth of 370 km. (230 miles). Outside the main seismic zone, some minor activity occurred in the Great Barrier Island, Ruawai (Northland), Paeroa, and Raglan regions. Shocks located in unusual regions occurred on 14th April and 27th May, from 100 to 200 miles east of Christchurch; and on 16th September, west of Cape Egmont. In all, 97 shocks were reported felt during the year; 71 in the North Island, 34 in the South Island, and 8 in both Islands. The maximum intensity reported in both Islands was M–M VI.

Seismograph Stations.—All the existing seismograph stations were operating continuously throughout the year. A special effort was made to improve the accuracy of recording at Wood-Anderson stations, and at some stations the speed of drum rotation was doubled to give clearer records of local earthquakes. Visits of inspection were made to the stations at Christchurch, Kaimata, New Plymouth, and Tuai. During the year, visits in connection with proposed installations were made to Arapuni, Opotiki, and National Park.

In July, a Wood-Anderson seismograph was installed at Cobb Power-station, West Nelson. A similar instrument was installed at Arapuni in November, but owing to interference by local artificial vibrations this seismograph will have to be removed to another locality. By arrangement with the Director of Meteorological Services, records from the Milne-Shaw seismograph at Suva were forwarded to this Observatory for interpretation and publication of readings. As a result of this, a large amount of valuable seismic data is being made available that would otherwise have remained unpublished for some considerable time.

Artificial Ground Vibrations.—With the co-operation of the Dominion Physical Laboratory and the Geophysical Survey, some records were made of the effects of artificial ground vibrations on the Observatory seismograph. This project arose mainly from the unusual vibrations at Arapuni and the necessity for finding a new site for the seismograph, and also for testing vibrations on the sites of proposed new stations.

Earthquake Wave Periods.—Work was commenced during the year on a series of measurements of wave periods in local earthquakes, recorded at various seismograph stations in New Zealand, to provide some provisional data for the design of earthquake-resistant structures. The results are being published as a series of Observatory technical papers.

Earthquake Location.—There was a considerable increase in the accuracy of local earthquake epicentres determined during the year, especially for shocks in the central regions. This was largely due to the new station established at Cobb in July.

Information.—A considerable amount of information regarding earthquakes was given to the Prime Minister's Department, the Earthquake and War Damage Commission, the press, and the general public.

TIME SERVICE

Time Signals Sent Out.—The usual time service was maintained throughout the year and the accuracy in timekeeping was higher than in previous years. The average error of the ZLW radio signals varied between 0·02 second and 0·03 second. The error exceeded 0·1 second on five days only, the maximum being 0·13 second.

During a large part of the year, special daily time signals were supplied for the use of the Lands and Survey Department in carrying out longitude work.

Public Clocks.—In January the Government Buildings clock developed a mechanical fault that resulted in large errors for a period of several days. Some further trouble gave rise to erratic performance in April. Apart from these, the maximum errors observed during the year were 65 seconds fast and 73 seconds slow. The clock is checked at 9 a.m. daily by special signal to the Observatory, and is regulated when necessary.

The synchronous electric clock stopped six times during the year owing to power failures. The maximum errors observed were 17 seconds fast and 22 seconds slow.

Quartz-crystal Clock.—A prototype quartz clock, made by the Dominion Physical Laboratory, was installed at the Observatory in January. After a period of preliminary trial, the clock was returned to the Laboratory in August for further tests and adjustments.

Extension of Time Service.—During the year an impulse dial, operated from one of the Observatory signal clocks, was installed in the 9 in. telescope room at the Carter Observatory. A similar dial was erected in one of the Observatory windows for the use of the public.

Horological Exhibition.—At the invitation of the New Zealand Horological Institute, this Observatory supplied an exhibit for the Institute's Horological Exhibition at Auckland in August.

GENERAL

Seventh Pacific Science Congress.—The Director and the senior professional officers attended the Christchurch session of the Congress in February. In connection with the Congress, Dr. Gutenberg and Dr. Richter of Pasadena and Dr. Hodgson of Ottawa visited the Observatory. Informal discussions with these visitors were of great assistance, especially in local seismic work.

Geophysical Conference.—The Director and two other officers attended the Department's Geophysical Conference at Christchurch in December.

Seminars.—Three seminars were held at the Observatory during the year for discussion on various aspects of research work. They were attended by representatives from Dominion Physical Laboratory, Geophysical Survey, and the Meteorological Office.

Interchange of Staff.—Arising out of arrangements made at the Geophysical Conference in December, 1948, interchange of staff was carried out with Magnetic Survey, Christchurch, early in 1949.

Apparatus and Equipment.—Repair and servicing of equipment was carried out by the Observatory workshop and by the Dominion Physical Laboratory.

Library.—Considerable progress has been made with the reclassification of the Library.

SOIL BUREAU

Director: Dr. L. I. Grange

SOIL SURVEYS

General Surveys.—The collation of data for the extended legend to accompany the North Island soil maps has been completed. The agricultural notes are now being edited by officers of the Department of Agriculture.

The South Island has been covered by the reconnaissance survey. The soils are being classified and maps are being compiled from the field sheets. Good progress has been made with the survey of the chemical properties of the soils. In the Nelson district the work is being carried out in co-operation with the Cawthron Institute.

Detailed and District Surveys.—About 580 square miles surrounding Lake Taupo have been mapped. Although approximately half of the area consists of flat and rolling land, most of the soils are coarser and apparently less fertile than the pumice sandy silts which have been so well developed at Ngukura. In the area mapped, the sandy silt soils are mainly confined to the strong-rolling and hilly land.

Satisfactory progress has been made with the detailed surveys of Gisborne flats, where 9,000 acres have been mapped, and of Central Otago, where 7,000 acres of orchard and potential orchard land have been examined.

The field survey of the Wairarapa Plains is now completed.

At the request of the Department of Island Territories a survey was made of the soils of Niue Island. In this isolated community the local production of foodstuffs is most important, and the limited soil resources must be husbanded with care. These soils are formed from volcanic ash, which lies on a rugged surface of coral limestone. Of a total area of 64,900 acres, only about one-half has a soil covering available for agriculture, the remainder consisting of bare limestone rock with the ash soil occurring in narrow fissures. This rocky land grows forest and coastal scrub. The deeper soils occur as pockets throughout the island and total approximately 32,000 acres. Some 24,000 acres are used for food-production on a five-year to nine-year rotation, with a spell of three to five years in which the soil is allowed to revert to a native shrubland cover. These soils are maintaining their fertility and producing good crops, although the interval between cropping tends to be shorter near villages and the soil fertility falls correspondingly. On some 8,250 acres, soils formerly used for agriculture have now reverted to fern and scrub, since these soils no longer have the natural fertility necessary to grow food crops. A solution of this problem is necessary for the future well-being of the Islanders.

Other surveys of small areas have been made at the request of various bodies. They include surveys of Raoul Island, the market-garden areas of Greytown, parts of the flats bordering Rangitikei River, and parts of Castlepoint County.

Five further surveys—namely, Matakaoa, Makara, Marlborough, Ellesmere, and Inchclutha—have now been finalized and reports are being prepared for publication.

Reconnaissance Survey of Fiji.—As the result of a visit to Fiji, a report was made to the Fiji Legislative Council on a proposed reconnaissance survey of the two main islands by the Soil Bureau.

SOIL CHEMISTRY

Soil Phosphates.—Radioactive phosphate added to a North Auckland and a Wellington soil showed that the plants secured practically all their phosphate from the added dressings.

Yellow-leaf in Phormium Flax.—In co-operation with the Botany Division, radioactive phosphorus was made available to the roots of healthy flax and to those affected by yellow-leaf. It was found that while the phosphate appeared in the leaves of healthy plants none appeared in the leaves of plants with yellow-leaf. This means that the roots of the diseased plants are not functioning normally.

Manganese Deficiency in Peach-trees.—Further tests show that reduction of alkalinity and application of manganese sulphate to the soil does not increase the manganese content of the leaves. At present it appears that the only practical remedy is the spraying of the leaves with the manganese salt.

Compost.—Assistance has been given to local bodies in the composting of organic waste at Auckland, Dannevirke, and Masterton. Analyses have been made of green flax waste at Foxton.

Clay Minerals.—These are identified by X-ray and thermal analyses. Results have been already used in soil mechanics in correlating data in different localities.

Bentonite Clays.—A method was found of improving natural bentonite clays in New Zealand by leaching with common salt solution. This may allow the use of deposits that were formerly considered to be of low quality.

Colour of Soils.—Soil colours have been measured by a photo-electric reflectometer method. Colour is a useful criterion in classifying soils. The method has not previously been used on soils.

Chlorosis of Orchard Trees in Central Otago.—A number of soils have been analysed for soluble salts, alkalinity, and free lime, and tree branches have been injected with trace elements. It appears that soluble salts and alkalinity are playing an important part in chlorosis of trees.

Liming of Southland Soils.—Some farmers in Southland consider that liming is overdone to the extent of affecting the health of lambs. Tests showed that liming had not been sufficient to make the soils alkaline, but on a number of farms adequate lime had been applied and lower rates could now be used. Under Southland conditions a substantial quantity of the lime applied is lost each year from the topsoil. Analyses indicated that on some farms potash could be added to the top-dressing.

"Fused Needle" in Pine-trees.—"Fused needle" occurs in pine-trees in the Athenree district. The content of hydrochloric-soluble phosphate in the soil is comparable to that in Queensland soils where a similar disease occurs and is remedied by the application of phosphate.

Soil Corrosion.—Asbestos-cement test pipes buried in gum-land soil corroded on the outside owing to soil water that was high in carbon-dioxide.

Metal pipes are being buried in the main kinds of soil in New Zealand to measure corrosion at two-yearly intervals.

SOIL BIOTICS

Trace Element Survey.—Pot trials on four soil types on the older coastal sands of North Auckland show that copper is deficient in all types, manganese in one, and zinc in two types. The indicator plants—rye-grass and white clover—gave a marked response following their application.

About 60 per cent. of the soil types in North Auckland have been assayed for available copper. Many of the strongly-leached soils are low in this element. The survey is being done in collaboration with the Animal Research Division of the Department of Agriculture.

Boron Uptake by Pasture Plants.—Pasture growing in pots was reduced in boron content when the pH of the soil was raised to 6·5 by liming.

Earthworm Survey.—The survey of species of worms in the North Island is almost completed.

Protozoa Survey.—A preliminary survey of Protozoa in New Zealand soils has disclosed that there are several widely-distributed species that may be of great significance in soil-fertility studies, and many species with a narrower distribution found only in certain soil types.

SOIL PHYSICS

Agricultural Soil Physics.—Physical measurements on a Canterbury wheat-farm showed that continuous cropping to wheat resulted in serious deterioration in soil structure. This was accompanied by a marked decline in yield. No appreciable improvement in soil structure was evidenced after one year under a grass cover.

The physical properties, particularly soil moisture relationships, of the various classes of Taupo pumice soils available for development are being investigated.

Soil Mechanics.—Standard tests have been carried out for airfield construction at Invercargill, Harewood, Milson, Auckland, and Suva Point, Fiji, and methods of solving difficulties encountered have been investigated.

Comprehensive tests have been made on volcanic soil available for earth-dam construction at Atiamuri. Problems similar to those at Whakamaru were encountered. At Lake Wanaka, investigations into "electrical drainage" of earth-dam foundation soil have led to the method being tried on a field scale by the Ministry of Works. Soils from the site of the proposed dam at Port Chalmers Reservoir were shown to be suitable for core material.

Reports have also been made on foundation sites at the request of various bodies.

Research Projects.—Problems encountered in the Rotorua-Taupo area have led to research into the unusual compaction properties of volcanic-ash soils. Following anomalous results from tests at Rotorua and New Plymouth, the relation of clay mineral composition and the physical properties of soils is being investigated.

WHEAT RESEARCH INSTITUTE

Chief Executive Officer: Dr. O. H. Frankel

From 1st April, 1950, the wheat-breeding section of the Institute will be amalgamated with the former Agronomy Division, under the name Crop Research Division. The cereal chemistry, milling, and baking laboratories at Christchurch will retain the name Wheat Research Institute and will continue with their former functions, including the testing of wheats bred at the Crop Research Division.

The functions of the Wheat Research Committee, which has supported the change, will be unaltered, and it will retain the same measure of control over the breeding-work as it had before.

WHEAT-BREEDING AND WHEATGROWING

New Varieties.—Eleven new varieties—built up over a number of years from several crosses the parents of which included Cross Seven, Tainui, Dreadnought, Holdfast, and some unnamed hybrids produced by the Institute in earlier years—were tested in extensive trials by the Department of Agriculture, and in two trials on the Institute's own areas at Lincoln and Springston. It was found that all of them performed in the majority of these twelve experiments distinctly better than the standard variety, Cross Seven. The performance was so good that a choice of the best four lines, which will now be taken into even more searching tests, proved difficult. These varieties have been giving very substantial yield increases over the older standard variety, Cross Seven, while retaining its valuable agronomic characteristics of a first-class header wheat. In baking quality they are closely akin to the standard. The especially promising line 202,01 has continued to excel; this year, however, having passed through several seasons of trials, it was found to contain a number of impurities, and has to be withdrawn temporarily for purification. Another six new lines, not yet tested beyond the Institute's own areas, have given good promise, and will now be tested elsewhere.

Dreadnought Wheat.—This variety is grown in the main in the Waimate-Studholme-Morven area of South Canterbury and on the tarry and limestone soils south of Oamaru. Both areas are distinguished by their high fertility (and consequent high crop yields). In both Dreadnought as a rule gives substantially higher yields than Cross Seven. In both wheat fits in well in the crop rotation, and is, on the whole, a highly important crop. Unfortunately, in recent years, Dreadnought has given a good deal of cause for worry. Firstly, it is not a header wheat, and if a header harvester is to be used at all, the crop has to be wind-rowed—a somewhat risky harvesting method that is in fact resorted to in about a third of the crops. Secondly, Dreadnought tends to lodge, and this has become much more widespread in recent years, no doubt owing to the reduced wheat area and to improve pastures. It has been the Institute's aim for some years to produce for these districts a wheat with the general characteristics of Dreadnought but with the tight chaff and short, stiff straw characteristic of a good header wheat. For this purpose an experimental area with a soil type similar to that prevailing in South Canterbury, was selected at Tai Tapu, and last season an area in Springston was chosen. Unfortunately the desired effect was not achieved; the combination of the factors which so frequently produce lodging of Dreadnought crops in its own area was not present in those areas selected for their vicinity to the main station at Lincoln. On these areas Dreadnought has shown no signs of lodging. In the coming season an attempt will be made to induce lodging by the application of nitrogenous fertilizer, and should this fail, the only remedy would be a substation in the Dreadnought area.

Hilgendorf Wheat.—This new wheat, first released for the sowing of 1948, had been grown in the preceding year on about 220 acres. In the past year for the first time there was an appreciable area, estimated at between 3,000 and 3,500 acres. To pool the experience of the first large-scale cultivation, the Wheat Research Institute approached grain-merchants with the request to distribute a questionnaire to their clients who had been Hilgendorf growers. By the end of March, eighty-three replies had been received, covering 1,200 acres (or more than one-third of the area sown): 45 per cent. of growers were satisfied, 26 per cent. were uncertain, 11 per cent. had lost their crops in one of the most destructive and widespread frosts for many years, and 12 per cent. were dissatisfied. Many growers considered the season, which was characterized by an extensive spring drought following an unusually dry winter, as one especially unfavourable for an early developing and maturing wheat. In these circumstances the experience gained makes this wheat appear fairly promising, especially in the Darfield-Sheffield-Hororata district, the Christchurch-Dunsandel district, in Rakaia, and in parts of Marlborough. The northern part of North Canterbury was less favourable; there the late frost damaged many Hilgendorf crops. In South Canterbury, with its many trees, and now with its relatively low acreage of cereals, bird damage is usually extensive, especially on an early wheat. On the whole, however, bird damage was not nearly so extensive as anticipated. Frost damage was not wholly harmful to Hilgendorf, because in a number of instances this variety escaped, whereas Cross Seven on the same farm was badly damaged. The impression of previous years was confirmed: that Hilgendorf is not as thoroughly reliable in all circumstances as Cross Seven; that in some circumstances it does even better than the standard, in many as well, and in others not nearly as well. To be widely grown, this wheat requires a fairly substantial incentive premium, which is thoroughly warranted in view of its extremely high baking qualities. Continuance of the premium of 1s. per bushel has been secured for the harvest of 1951.

For the last three years a number of lines, which were selected from the material that yielded Hilgendorf, were tested at Lincoln, and also, in the last season, in four trials by the Department of Agriculture. One line, 140,014/4, has so far yielded consistently and substantially more than the original Hilgendorf; in the majority of last season's trials it out-yielded the standard, Cross Seven. In baking quality it is distinctly superior to Cross Seven, though perhaps not quite as good as Hilgendorf. If these favourable results are confirmed, this wheat holds out the promise to solve the problem of a high-quality wheat. Further trials and seed propagation are being advanced rapidly.

Another line of work points in a similar direction. As soon as Hilgendorf was discovered as a very high-quality wheat, crosses were made with Cross Seven, and these, through alternate use of a glasshouse generation, have been rapidly advanced. Six hundred lines from these crosses are now entering into the yield-trial stage. This highly promising material is used also for the purpose of ascertaining whether under New Zealand conditions selection for protein content will efficiently advance a breeding programme for baking qualities. It will be remembered that Hilgendorf itself exceeds Cross Seven on the average by 2 per cent. in protein content. Many hundreds of single plants were tested for protein content last year, and this year similar tests were carried out on their progenies. This work is being continued further.

Disease Resistance.—It is widely believed that the incidence of mildew (*Erisyphe graminis*) has been increasing in seriousness in recent years. In consequence a breeding project for mildew resistance was started recently and is being advanced as rapidly as possible through growing two generations in one year, one of them under glass. It is hoped that a mildew-resistant Cross Seven type will be available in a few years' time.

Investigations.—Studies on the inheritance of quantitative characters and on the effects of various methods of selection are being continued.

CEREAL CHEMISTRY, MILLING, AND BAKING

Flour-quality Investigations.—The study of the causes of the dark crumb colour of breads made from high-extraction flours has been carried on, with interruptions. At the present stage it is possible to put forward the following explanation: the dark crumb colour is due to the high germ content of high-extraction flours, not to their bran content. Wheat germ contains a substance that forms a dark oxidation product when, during dough fermentation, conditions—viz., acidity—become favourable for certain oxidizing enzymes. A further purely atmospheric darkening takes place on the cut crumb surface of such bread.

Applied to milling, this explanation suggests that crumb colour could be improved by excluding from the flour all mill streams rich in germ, but due attention to vitamin content would be necessary. It also provides an analytical method for measuring the contribution that individual mill streams make to the total darkening in a flour. This method should be valuable as an aid to improvements in the milling process. The results obtained so far are being written up in the form of two scientific papers.

Vitamin B_1 Content of New Zealand Flour.—From 1st March, 1949, the flour-extraction rate was reduced to 78 per cent. This made a general improvement in the baking quality of the flour and caused the vitamin B_1 content to fall from 3·5 p.p.m. to an average of 3·2 p.p.m.

Damage by Wheat-bugs.—Early in January the Institute's officers noticed that some wheat lines of the new harvest had been attacked by the so-called "wheat-bugs." These insects puncture the developing grain in order to suck juices from it and, in so doing, inject small amounts of saliva into the grain.

The saliva contains digestive enzymes which, even in the tiny amounts left behind by the insects, cause the baker's dough to become soft and sticky and the bread to be coarse and unpalatable. A small percentage of punctured grains in a milling grist will ruin the baking quality of the flour, and a severely damaged line can seriously impair the baking quality of other lines of sound wheat with which it may be mixed.

Fortunately there were damaged lines amongst the first received for testing, and the Institute sent a warning to every miller and grain-merchant, together with a copy of "Wheat Diseases and Insect Pests" (by Blair and Morrison of Canterbury Agricultural College; published by the D.S.I.R.): a warning was especially necessary because the visual evidence of the attack of wheat-bugs, a small white patch on the cheek of the grain, is easily overlooked, and there had been practically no bug-wheat in New Zealand since it was first observed here in 1936 by Mr. H. E. West.

Fortunately the value of wheat for feed or for seed is unimpaired by the attack, and many damaged lines have been diverted to these purposes.

Service Work for Millers and Bakers.—Because of the presence of bug-wheat, millers sent in unusually large numbers of wheat samples for milling and baking tests, and about 7 per cent. of these lines were rejected for milling because of insect attack. Up till the end of March there were only two instances reported of difficulty in bakeries caused by flour damaged by the wheat-bugs.

At the request of bakers the Wheat Committee arranged for weekly tests to be made by the Institute on the flour from every mill.

Millers and bakers made increased use of the Institute's testing and advisory services.

Wheat-breeding Samples.—Many of the wheat samples harvested from selection trials at Lincoln and Springston were found to have been attacked by wheat-bugs. This meant that any differences in baking quality inherent in the varieties represented by the samples would be altered, or even overshadowed, by differences in baking quality as a result of insect attack. Baking-test results, therefore, would have had little real significance, so the tests were not made. It is unfortunate that a year's work in some of the breeding projects has been lost in this way.

Protein content is not appreciably affected by bug attack and over 1,500 determinations were made on breeding samples.

Baking School for Apprentices.—In November a school for bread-baking apprentices was opened at the Institute. The semi-commercial bakery was remodelled, and additional machinery provided by the Education Department to enable up to twelve students at one time to undergo a four weeks' course in practical baking. An additional baker was appointed to the staff in order that the school may operate almost continuously and so deal with consecutive groups of apprentices under direction from the Commissioner of Apprenticeship.

Although no courses for adult bakers were held in this year, it is intended in future to provide for at least one course in each year.

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——— "A Self-propagating Structural Change in *Triticum*—II: The Reproductive Cycle." *Heredity, 3,* 293–317.

Stern, Rosa, and Bird, L. H. (1949): "The Use of the Waring Blendor in Biochemical Work." *Biochem. Jour. 44,* No. 5 (1949), 635–7.

REPORTS OF RESEARCH COMMITTEES OF THE COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BUILDING RESEARCH

The establishment of a separate Building Research Organization is still under consideration. In the meantime work has continued in the various branches of the Department along similar lines to that done last year. The Dominion Laboratory has been investigating the various problems connected with concrete-reactive aggregates—the use and occurrence in New Zealand of pozzolanic materials, &c.—testing concrete tiles, &c. In the paint section of this Laboratory the specification testing of paints has continued, and progress has been made on the paint-fence trials that are being undertaken in various parts of New Zealand. Besides other building research, the Dominion Physical Laboratory has now commenced the testing of the efficiency of different types of domestic fireplaces. This Laboratory is also continuing its work on dam-site foundations and the physical testing of concrete and concrete aggregates. Research work has continued at the Plant Diseases Division on timber-preservation.

The Dominion Laboratory's work is reported under "Rocks, Minerals, and Clays" on page 20 and "Building-materials" on page 27, the Dominion Physical Laboratory's work under "Building Research" on page 29; and the Plant Diseases Division's work under "Timber-preservation Investigations" on page 68.

HOP RESEARCH

Station Director: Mr. A. S. Nash

An established hop-garden of 8½ acres in Riwaka has been purchased as the headquarters of the Hop Research Station but it is not in full operation because the necessary buildings have not yet been constructed. In the meantime a substantial research programme is being carried out by the Station Director, by the Cawthron Institute, and by the Dominion Laboratory—who are all participants in an integrated plan of research for the benefit of the hop industry. The major problem immediately facing the industry is that of black root-rot, which takes heavy toll of plants year by year. Much of the research is focused on this problem, but other problems are also receiving attention. The Director is concentrating mainly on hop breeding and selection for quality and resistance to disease, coupled with improvement of cultural practices; the Cawthron Institute on identification and chemical control of diseases, together with soil and chemical studies; and the Dominion Laboratory on hop-drying practice. The principal investigations are outlined below.

HOP RESEARCH STATION

Six manurial trials have been laid down in established commercial gardens on different types of soil in the Waimea County. The crops have been harvested, and although the data have not been fully analysed it appears that a new fertilizer mixture at a high rate of application is showing some promise. Higher yields and better quality have resulted on some of the plots.

Dried samples of a range of commercial varieties have been sent to Wye College, England, for chemical assessment of brewing quality.

New hybrid hops have been raised from seed and transferred to the Station. A collection of hop varieties and types drawn from all parts of the Nelson district has been established, and lines of two varieties showing considerable resistance to root-rot have been put out for propagation.

New varieties from Wye College and others from Tasmania have been maintained in quarantine in the North Island.

Following a small preliminary aerial survey, the R.N.Z.A.F. photographed a much larger area of hop-gardens in the areas affected by disease. The mosaic maps will be of inestimable value to ground surveys and field experiments, as well as forming a valuable record of the present status of disease in commercial gardens.

CAWTHRON INSTITUTE

A disease survey in forty-eight gardens distributed throughout the Waimea County has confirmed that the most prevalent disease is black root-rot (*Phytophthora* sp.) and that its intensity varies considerably on different soils. Wai-iti, Wakefield, and parts of the Upper Moutere Valley appear relatively free. During the survey an unidentified rot of the crown of the hop-plant was noted in several gardens, and this is now being studied to determine its nature and control. Symptoms suggestive of virus disease, especially nettlehead, have been found in four gardens in the Wai-iti Valley and in one in Riwaka, but no symptoms of downy-mildew or of verticillium-wilt have been observed.

Soil treatments for possible control of root-rot, using chloropicrin and DD, have been extended, and calcium cyanamide has been added to the chemicals under test. The portion of the trial that is in its second season shows hop growth to be best on DD plots, with chloropicrin plots intermediate, and untreated plots poorest. With first-year plants the best growth is on DD and calcium cyanamide plots in the majority of cases.

Massive doses of sulphate of potash (2 tons per acre) are being tried in seven gardens on different soils to see if the treatment will increase the resistance of the plants to root-rot.

Ten chemicals have been tested this year for any injuriousness to hop crowns when exposed for pruning in the spring, but no damage has been observed. Bordeaux mixture seems the only specific that has depressed the subsequent growth below that of the untreated plants.

Hop cuttings of five varieties have been tested for susceptibility to *Phytophthora* by planting in infected soil, after hand inoculation. The results are in line with growers' experience that the Fuggle variety is resistant, while Californian and Grape varieties are susceptible.

It has been determined that the *Phytophthora* organism grows well in soils varying from acid to nearly neutral reaction (pH 4·75 to 6·4). Maximum growth is between pH 6·0 and 6·4—the values that might be expected in soils which best suit the growth of hops.

Over one hundred soil samples, taken from at least one garden of every grower in the Nelson district, have been collected for chemical analysis. Determinations so far made indicate a generally low potash status. There is a wide variation in pH, with some gardens clearly needing lime treatment and others so heavily limed that there may be danger of induced mineral-deficiency disorders.

A beginning has been made on the chemical analysis of hop-plant tissues to determine the distribution of minerals within the plant and the hop cone, the effect of standard fertilizer at different rates on the nitrogen and mineral content of the plant, and the correlation of the mineral content of the plant with the mineral status of the soil.

DOMINION LABORATORY

The Chemical Engineering Section has constructed a small experimental drying-kiln capable of giving excellent control over air flow and temperature. A design has been prepared for an up-to-date kiln for the Hop Research Station based on a forced-draught system. It incorporates ideas gathered by the Director of the Station while in England and by the Senior Engineer of the Laboratory while in Tasmania.

MANUFACTURERS' RESEARCH COMMITTEE

Secretary-Executive Officer: Mr. C. P. McEvedy

Throughout the year the Committee has continued its policy of encouraging and assisting industrialists to apply the results of scientific research to the processes and problems of manufacturing industries, and also to utilize the special facilities available through the Department. The Committee is convinced that the fuller utilization of the results of research is contributing substantially towards achieving greater efficiency in methods of production.

A close relationship has been maintained with the New Zealand Manufacturers' Federation and its district and trade associations, by providing liaison with the Department.

Research Associations.—The activities of the five industrial research associations, which are financed by equal contributions from Government and industry, have been reviewed at regular intervals, and their success is largely due to the interest and enthusiasm of manufacturers who carry the responsibility on behalf of industry by sharing in the management of the organizations. In view of the progress achieved, the Committee considers that the establishment of such associations is one of the best means of bringing the benefits of science to manufacturers. Even so, shortages of scientific personnel and laboratory accommodation have restrained the Committee from actively encouraging the establishment of additional associations in the meantime. For the same reasons, the plan to inaugurate industrial research fellowships on similar lines to research associations has been deferred. Instead, attention has been concentrated on the consolidation of existing associations.

Service to Industry.—Valuable assistance on scientific and technological matters has been rendered to industry by the Dominion Laboratory and other branches of the Department. The needs of industry for special laboratory and workshop services that are not available elsewhere in New Zealand have been provided by the Dominion Physical Laboratory, the Auckland Industrial Development Laboratories, and the Industrial Development Department of Canterbury University College, on the advisory bodies of which the Committee is represented.

The Industrial Liaison Officers continue to serve manufacturers by acquainting them with scientific developments, and also by making the facilities of the Department known and available to industry.

Many other matters of a more general nature have received the attention of the Committee in the course of their advisory work on how the resources of the Department can best be directed for the assistance and development of the manufacturing industries.

RADIO RESEARCH COMMITTEE

The Committee has continued its work of promoting and co-ordinating radio research activities in New Zealand. Within the Department these are undertaken by the Dominion Physical Laboratory (see p. 30).

Seagrove Radio Research Station.—An applicant from the United Kingdom has been appointed to the post of senior physicist and a formal agreement for the operation of the station has been signed by Auckland University College and the Department. Establishment is now complete and the station has been taken over by the college. Details of the programme of investigations will not be decided until the arrival of the senior physicist.

Meteor Research.—A grant has been made to Canterbury University College to enable Dr. C. Ellyett to undertake investigations by radar methods of meteor showers, velocities, turbulence, and correlation with sporadic E. Equipment for the purpose is now being assembled.

Auroral Photography.—Carter Observatory is commencing a programme of auroral photography financed by grant. Staff has been secured and good progress made in sorting existing records prior to revision and in establishing the camera base-line in Southland.

TOBACCO RESEARCH

Station Director: Mr. R. Thomson

The weather during the past season was abnormal. The winter rainfall was only moderate, and this was followed by a very dry spring. November was characterized by frequent showers, and this facilitated planting of tobacco and to some extent offset the preceding dry conditions. The latter part of December was wet with occasional low temperatures. Warm dry weather was then experienced for the remainder of the season, night temperatures dropping sharply in March. A severe frost on 13th March killed tobacco in some parts of the district, but the crop at the Station escaped damage.

In the 1948–49 season the tobacco crop on the Station was damaged by hail and on this account the crop was a light one, being only 983 lb. per acre. No data are yet available for the past season, but the crop appears to be average.

RESEARCH PROGRAMME

As in previous years, research work on tobacco was carried out jointly by the staffs of the Tobacco Research Station, the Cawthron Institute, and the Dominion Laboratory.

Work at the Institute included investigations into the nature, dissemination, and control of various diseases, together with disease surveys; studies of the intake of plant nutrients and their effect on the composition of the leaf; chemical analysis of the leaf from the fertilizer plots and from curing experiments; survey of tobacco soils; and investigations into specific soil problems.

Work at the Research Station covered all phases of the crop in the field, starting with seedling-bed methods and treatments, and following through various aspects of fertilizer application, cultural methods, variety trials and seed-production work, plant-breeding, and control of diseases in the field.

Work by the Dominion Laboratory was concerned with the engineering aspects of curing and drying.

SEEDLING-BED INVESTIGATIONS

On steam-sterilized soil the growth of tobacco seedlings with ¾ lb. tobacco-fertilizer per square yard was better than with ½ lb. or 1 lb., or with ½ lb., plus supplementary nitrogen. The recommended practice of covering the seed with sand after sowing resulted in a better germination and growth than leaving the seed uncovered. The distribution of the seed with a watering-can gave as good and as uniform a stand as the usual practice of sowing with dry sand. Commercial aids to transplanting proved of no advantage, either at pricking out or when planting in the field. For the control of worms in seedling beds, derris dust or permanganate of potash proved satisfactory, but bluestone killed off many of the young seedlings. This season there was a marked increase in the number of seedling beds successfully direct-seeded by growers.

SOIL STERILIZATION

This service is becoming increasingly popular with growers and the 450 cubic yards steamed this year was a record.

FERTILIZER EXPERIMENTS

A properly balanced fertilizer applied in correct quantities is necessary if maximum yield combined with high quality is to be achieved. Increasing the quality of fertilizer up to 1,400 lb. per acre resulted in improved yield with no reduction in quality, but higher rates gave a falling off in quality and no increase in yield. In combination with phosphate and potash, 4 per cent. nitrogen gave a higher yield than 3 per cent., but adequate potash (at least 8 per cent.) was essential, otherwise quality suffered and maturity was delayed. Low phosphate resulted in reduced growth and later maturity. The inclusion of 2 per cent. magnesium in the fertilizer was beneficial to both yield and quality. A balanced supply of nitrogen from organic and inorganic sources was superior to mixtures where one type of nitrogen predominated. No differences were noticeable in the growth of the crop from high and low levels of calcium. On boron-deficient soils in the district 5 lb. borax per acre resulted in a marked improvement in growth and quality.

In a cover-crop experiment, tobacco following oats and vetches produced the highest yield, although the leaf was not as bright as that following rye-corn or Italian rye-grass. Tobacco following lupins produced a poor leaf, dark in colour, and inferior in texture, with much green. Where the quantity of fertilizer was varied in conjunction with the cover crop, large applications of fertilizer following leguminous cover-crops resulted in rank tobacco. The omission of nitrogen from the mixture corrected the position somewhat, but lupins still caused late maturity of the crop.

In a trial where the spacing between the rows and the plants was varied, the extra width between rows facilitated working and favoured earlier ripening. There was no reduction in yield, provided the number of plants per acre was not reduced. When the height of topping was varied, low topping reduced yield but produced heavier-bodied leaf of a bright colour. High topping gave the highest yield, but the increase was mainly small narrow tips.

CHEMICAL INVESTIGATIONS

The analyses of some 90 samples of tobacco from the experimental plots at the Tobacco Research Station and from the Takaka experimental area have been completed. The more important points are as follows:—

Small applications of borax at the rate of 5 lb. per acre raised the boron content of tobacco leaf from 17·9 p.p.m. to 32·5 p.p.m. A further substantial increase in boron content was obtained when the application was increased to 10 lb. per acre. Borax did not appear to have any effect on the nitrogen and reducing-sugar contents of the leaf.

In the 1948–49 season lime treatment or the omission of calcium from the fertilizer mixture had no marked effect on sugar, nitrogen, or mineral content of the leaf.

Leaf heavily infected with mosaic had 2·11 per cent. nitrogen, compared with 1·37 per cent. for non-mosaic leaf, and had only 16·67 per cent. sugar, compared with 25·13 per cent. for non-mosaic leaf.

A commercial fertilizer mixture gave a higher leaf-nitrogen figure than the standard fertilizer used at the Station (containing equal proportions of nitrogen in nitrate, ammonia, and organic form) or than a special mixture containing two-thirds of the nitrogen as nitrate of soda. The sugar content of the leaf from the different experimental treatments was not appreciably affected.

The effect of dolomite in the manurial treatment of tobacco was reflected in higher percentages of magnesium in the tobacco samples, but there was no significant effect on either sugar or nitrogen contents.

Different distances of spacing or different heights of topping had no marked effect on either sugar or nitrogen contents of leaf samples.

The omission of nitrogen or of sulphur from the fertilizer mixture gave low nitrogen figures in leaf samples. A low sugar content was associated with leaf grown without nitrogen. High nitrogen and high sugar content characterized leaf grown without potash. Omission of phosphate or calcium did not give any outstanding differences in either nitrogen or sugar content.

Analyses of leaf samples from the tobacco plots where cover-crops had been disked in prior to planting gave the following percentages for nitrogen and total reducing sugars respectively: blue lupins, 2·18 and 15·57; rye-corn, 1·15 and 26·35; rye-grass, 1·28 and 26·01; oats and tares, 1·54 and 25·05. In each case the tobacco crop was manured with 1,200 lb. of standard fertilizer per acre. The figures emphasize the detrimental effect of lupins as a cover-crop.

Analyses of leaf samples from the Takaka experimental plots gave high nitrogen (2·85 to 3·25 per cent.) and low sugar (3·61 to 8·94 per cent.). The samples were abnormally high in calcium (5·80 to 6·75 per cent. CaO), in magnesium (1·18 to 1·59 per cent. MgO), and in total ash (17·05 to 21.·48 per cent.).

DISEASE INVESTIGATIONS

Disease Surveys.—The examination of the seedling beds of twenty-seven growers indicated an unusual freedom from root diseases this season. Small amounts of damping-off disease, black root-rot, and serious mosaic infection were found, while angular leaf-spot was almost absent.

The survey of diseases was continued in representative gardens throughout the district this season and showed that mosaic was present to about the same amount as in the previous season, but infected plants showed more extensive damage. A noticeable feature was that bed-sown plants showed much less mosaic (9·3 per cent.) than did pricked-out plants (22·2 per cent.). An unidentified disease known as "yellow stunt" appeared to be extending, and an endeavour is being made to determine its nature.

Mosaic.—Further confirmation was obtained of the spread of mosaic by handling. In the control plot the percentage of infection was 4·6, while in an adjacent plot where 1 per cent. of infected material was handled the infection was 84·3 per cent.

In a plot where the plants, with no intentional infection, were dipped in arsenate of lead before planting, the percentage of mosaic was 37·6.

Black root-rot.—The more important points emerging from investigations into this serious disease are as follows:—

Some fifty species of weeds were tested to ascertain their susceptibility to black root-rot. Broom, *Alchemilla arvensis,* wild carrot, sucking clover, daisy (*Bellis perennis*), and dwarf mallow were all infected either seriously or to a moderate extent by the disease. Cankers suggestive of black root-rot were found on gorse plants, but typical spores were not seen. Over forty species of weeds remained healthy under the tests.

The cover-crops white clover, cow-grass, and vetch proved to be not susceptible to black root-rot. This result differs from overseas experience in respect of white clover and to a less extent red clover, and suggests that under certain growth conditions the plants escape infection.

In chemical control trials in the soil of seedling beds, calcium cyanamide at the rates of application employed was toxic to the tobacco seedlings and many were killed. TMTD gave little control of the disease. The best result was obtained with chloropicrin, used at either 4 ml. or 6 ml. per square foot, when the amount of heavy root infection was reduced from 83 per cent. to 8 per cent.

Verticillium-wilt.—Tests with plants which might be used as green-manure crops showed that wheat, barley, oats, rye-corn, vetch, blue lupins, and rye-grass were practically free from infection when grown on a badly-infected field. Chloropicrin used as a soil disinfectant at the rate of 4 ml. per square foot appeared to control the disease, but this treatment would be practicable only for small areas because of cost.

INSECT PESTS

A severe outbreak of tobacco leaf-miner occurred in the Pokororo district this season. The origin was traced to a large area of old stalks that were not ploughed under. Dusting with DDT checked the pest sufficiently to allow the crop to make a fair recovery, but later broods of the moth were plentiful though not so destructive. Infestation everywhere was greater than usual, and it appears that this pest may be on the increase. Vegetable weevil was also more plentiful than usual in the seedling beds. Work was commenced to determine whether benzene hexachloride had any tainting effect on the leaf, in view of its possible use in controlling wireworms.

PLANT-BREEDING AND SEED-PRODUCTION

Breeding for resistance to black root-rot was advanced another stage. Several trial plots were set out on infected areas in comparison with commercial varieties and some lines proved very promising as regards both resistance and type of leaf. Samples of leaf have been kept for determination of quality. In breeding for resistance to mosaic some lines have proved highly resistant but are still not of the desirable flue-cured type. They have been further back-crossed to their flue-cured parents. A start has been made towards breeding for resistance to verticillium-wilt.

The bulk of the seed for the commercial tobacco crop is produced by the Station. The policy is still to distribute seed from selections made from imported seed and once tested for performance and trueness to type. Current requirements are being met and a satisfactory reserve of seed maintained.

VARIETIES

Harrison's Special 215 maintained its place of high yield combined with good quality. Special 400 was of high quality but did not yield as well, and produced a high proportion of laterals. Delcrest, a new Canadian variety, proved the most resistant to black root-rot, and also had the highest proportion of bright leaf, but the leaf was of the narrow type not favoured by growers or manufacturers. Three lines out of eleven received from Virginia proved promising, and were included for further trial. Two varieties from South Africa proved very susceptible to black root-rot and produced very narrow leaves, as also did an Australian variety.

In a trial of Burley varieties on black root-rot infected soil the varieties Ky. 33 and Ky. 34 from Kentucky, and Haronova and Harmony from Canada, proved highly resistant compared to the susceptible local variety. These varieties also yielded well on non-infected soil.

FIRE-CURED TOBACCO

This type is imported into New Zealand for blending into certain mixtures. A further area of varieties from the United States of America was grown this season, the crop making good growth and looking very promising both for yield and quality. It has been harvested and is at present being cured.

KILNS AND CURING

Work with the small experimental kiln was continued. It is proposed to build a full-sized kiln, designed by the Dominion Laboratory, in time for operating next season. A group of three experimental curing-cabinets in which temperature and humidity can be accurately controlled and recorded was installed. Some work was commenced on the effect of varying temperatures and humidities on the curing of tobacco leaf and on the quality of the cured product.

EXTENSION AREAS

Three plots of tobacco were grown in the Takaka Valley this season, two being on the sites of last season's experiments and one on new land. Stormy weather conditions again damaged the leaf, although not as severely as last season. At Marahau some experimental plots were laid down in order to investigate an obscure soil condition. On a Moutere area a trial was carried out embodying different levels and types of nitrogen.

TOBACCO SOIL SURVEY

The Cawthron Institute has given careful consideration to the acreage of flue-cured tobacco which might be grown successfully in the Waimea County, bearing in mind the maintenance of other valuable intensive crops and the necessity for spelling land used mainly for flue-cured tobacco. Of the total area of 12,000 acres available for flue-cured tobacco, and making allowance for the spelling of the land once in two years, it is considered that the maximum annual area should not exceed 6,000 acres. It must be noted, however, that further experimental work is required before the highest quality of leaf can be expected from the less desirable soil categories.

The soil pedologist has assisted the Commissioner of Crown Lands in the selection of tobacco land suitable for the settlement of returned soldiers, and has advised farmers on their soil problems.

A number of soil samples has been examined for texture, total nitrogen, and available plant food with a view to the improvement of quality in tobacco.

AREA OF TOBACCO, 1949–50

Although it has not been possible to revise the tobacco maps showing the exact distribution of the crop in the Waimea County, a study of the acreages applied for by growers and made available by the Tobacco Board shows a decrease of 493 acres on last year's figure of 4,393.

REPORTS OF INCORPORATED RESEARCH ASSOCIATIONS

THE DAIRY RESEARCH INSTITUTE (N.Z.)

Director: Professor W. Riddet

The financial year of the Institute ends on the 31st July, and a separate report will then be issued by the Institute. The following summary is on the investigations up to 31st July, 1949, and not included in the Department's annual report of last year.

Vitamin A Potency of Butter.—The survey on the vitamin A potency of New Zealand butter has been completed. The most striking feature of the results is the high values recorded each year for both carotene and vitamin A during the winter months of June, July, and August, in comparison with the much lower values for December, January, and February. In the Northern Hemisphere the reverse relationship holds, high values for both constituents occurring when the cows are on pasture during the summer, and low values in winter when the carotene content of the diet is low. It is surprising to find that, whatever the nature of the season, minimum values for both carotene and vitamin A are always recorded in New Zealand from December to March. It is unlikely that stage of lactation is responsible, and some unusual factor in New Zealand summer conditions—presumably in the pasture—appears to be the most valid explanation. Despite the fact that potencies are lowest when the production is high, the average annual potency compares very favourably with that of summer butter produced in the Northern Hemisphere. It is considerably higher than the average annual potency of United States butter, but very similar to butter made in the Pacific Coast States of Washington and California.

Non-washing of Butter.—Continuing these experiments, with poor-quality cream it was found that the omission of wash and chill water made a difference, but it amounted to only one-fifth of a point in average grading score.

Land-cress Taint in Cream and Butter.—It has been shown that when cress taint has been developed in cream by heating the cream to boiling point for thirty minutes, the tainting substance can be destroyed by the addition of chlorine solutions, and investigations were made to determine whether chlorine had any deleterious effects on butter quality. Hypochlorite addition to give up to 200 p.p.m. available chlorine in cream free from cress-taint had no appreciable effect on quality. These investigations are continuing.

Cream from Returned Milk.—Butter frequently develops a tallowy flavour when made from cream obtained by separating returned bottled milk of town supplies, and experiments have shown that a 10 per cent. inclusion of this cream in a churning gives a definite tallowy flavour in the butter after four months' storage, whilst 5 per cent. will cause some deterioration of flavour. It appears that the action of sunlight on the milk initiates oxidation of the fat.

Effect of Temperature Treatment of Cream on Body of Butter.—It has been found that if cream is held at 60°F. overnight and cooled just before churning, the butter is very much softer than that obtained by the usual practice of cooling cream to churning temperature (42–48°F.) and holding at this temperature overnight. The more-plastic butter produced from cream held at a high temperature is normal in other respects, but there is an increase of fat loss during churning. First cooling the cream to about 45°F., then warming and holding overnight at 60°F., and cooling before churning avoided the increase in fat loss. Attempts to increase the firmness of butter by holding cream at a temperature of 35°F. before churning were unsuccessful.

Alfa Continuous Buttermaking Process.—Experiments showed that "heavy" cream from vacreated cream was always higher in moisture content than that from flash-pasteurized cream. It was thus made clear that difficulties of moisture control encountered with the Alfa process were largely due to the properties of vacreator-treated cream.

Casein.—The Institute has co-operated in the formulation of standard specifications for water paints, and has participated in trials of paints for use on interior walls of dairy factories.

Starters for Cheese-manufacture.—The Institute has continued to act as the main source of supply of starters to cheese-factories throughout New Zealand, and the reputation of single-strain starters has resulted in requests for the supply of cultures to other countries. An endeavour is being made to find eight completely unrelated cultures, which would enable managers to use two cultures each day in a four-day rotation. Only seven cultures have so far survived the test of commercial use, but no doubt others will be disclosed. A new phage has been encountered that shows very unusual action, but it is still under investigation.

Cheese-manufacture.—Experiments on the relative effects of various procedures on the expulsion of moisture from cheese curd during manufacture were continued, and it has been found that a significant difference in moisture content between the final control and experimental cheeses is most readily brought about by variations in the size of cut, the amount of dry-stirring, and the proportion of salt added to the curd. The speed of agitation has little or no effect, while cooking temperature has to be varied by at least 4°F. before

a difference in moisture content is apparent. Investigations are continuing on the effect of variation in manufacture in relation to moisture content and flavour at maturity of cheese. A series of experiments were made to find the effect on cheese if the milk was passed through a separator and the cream and skim-milk was immediately remixed in the vat. The separator treatment of the particular milk-supply used did not adversely affect its cheesemaking qualities.

Cheese Flavour.—A series of experiments were carried out in which cultures of lactobacilli isolated from cheese and known to influence cheese flavour were sprayed on to cheese curd towards the end of the manufacturing process. The results indicated quite definitely that the cultures exerted an influence on flavour as the cheese ripened, but the degree of influence was disappointing. Progress was made in a study of the growth requirements of lactobacilli, and it was found that potassium and manganese ions have marked stimulating properties for the lactobacilli concerned in cheese-ripening. Some preliminary trials indicated that potassium may have a significant effect on the development of cheese flavour, and further investigations are being made.

Control of Mould on Cheese Rind.—Successful small-scale trials were made with an ozone-producing machine, and it was found that the presence of 0·3 p.p.m. by volume of ozone prevented the growth of mould on fresh cheese even in the presence of heavily-moulded cheese.

Blue-veined Cheese.—Roquefort-type cheese was again made on a small scale, but the facilities for curing the cheese are limited until the special curing-room is completed.

Other Projects.—The Institute has also carried out investigations on dairy-cow nutrition, on the relative yields of front and rear quarters of the mammary glands of Jersey and Friesian cows, on daily variations in herd average, and on weights of body organs.

NEW ZEALAND FERTILIZER MANUFACTURERS' RESEARCH ASSOCIATION (INC.)

Director: Dr. M. M. Burns

Much of the year was taken up in finding and negotiating for a suitable area of land containing important soil types, laboratory accommodation, and facilities for pot culture studies with plants. These requirements have been met in a property located in East Tamaki, Auckland, which is also within easy access of the main fertilizer-works. The extensive area, including excellent buildings, was purchased by the Department, and 9 acres, which include two important soil types and adequate accommodation in the main block of buildings, has been leased to the Association. Plans have been completed for the conversion of the buildings to provide laboratories and associated facilities, including a glasshouse and an outdoor enclosure for pot culture studies. The remainder of the area is to be taken up for extension of the work of several Divisions of the Department, and this will permit close collaboration with allied research workers.

A physicist was appointed, and commenced duties in October. He is making a study of the uptake of native and added phosphorus from the Red Hill sandy loam to which radioactive phosphorus has been added. An agronomist has also been appointed, and has recently taken up his duties after visiting experiment stations in the United States of America. He will be responsible for the pot culture studies.

The circulation of literature to members of the Association was continued, and seven special reports were prepared and distributed.

NEW ZEALAND LEATHER AND SHOE RESEARCH ASSOCIATION (INC.)

Acting-Director: Mr. F. G. Caughley

The report covers the first year of the Association as an incorporated body. The year has shown the completion of many investigations, and good progress in others. A Director has now been appointed, and it is expected that he will take up his duties towards the end of 1950. The staff now includes two research chemists. The total membership has reached forty, and subscriptions now exceed the present maximum Government grant, which, based as a pound-to-pound subsidy, it is hoped will be increased.

Plans, subject to Government approval, have been made to open a new laboratory at Lower Hutt, and with new plant, apparatus, and adequate stocks of material, this would allow the work of the Association to be considerably extended.

Leather-manufacture.—Tanning trials to determine the efficiency of the materials used for vegetable-tanned sole-leather with single unblended extracts have confirmed by actual figures the general comparisons accepted by the industry. Further developments indicate that the procedure with blended extracts may be applied to tannery practice. Many other investigations of special tanning problems were made by analyses, examination, &c.

Hides.—Full-scale trials have been started to investigate the superior leather yield and quality claimed for the brining process of curing hides and calf-skins as compared with the salt-stack method, and reactions in storage and tannage are being studied.

Pelts.—Investigations in the fellmongering of sheep-pelts and lamb-pelts were continued, but through the limitation of staff none of the major projects in these investigations could be started.

Shoe-manufacturers' Problems.—The shoe-manufacturers submitted nearly all of the 114 problems on footwear, and about three-quarters of these arose from complaints by customers after a period of wear. The effects of perspiration and the overheating of wet soles were found to be the cause in nearly half of the customers' complaints of faulty footwear, and tight-fitting shoes or rubber and other impervious soles were often associated with the perspiration-rotting of upper leather. Only in a few cases were weak material, or faulty workmanship, construction, or material, mainly responsible for the complaint. Except in a small group where ordinary hard wear had been responsible, the remaining cases were mostly found to be caused by various chemical agents contacted during wear.

NEW ZEALAND POTTERY AND CERAMIC RESEARCH ASSOCIATION (INC.)

Director: Mr. W. Vose

The laboratory has now been equipped as initially planned, and during the year a steady rate of progress in research projects, consultation with the industry, and general assistance to Government and other bodies, has been maintained.

RESEARCH

Raw Materials.—The results of the earlier work upon the sources of koalin-bearing deposits in New Zealand were reported and investigations extended to include clays from Central Otago, North Auckland, Central Canterbury, and Stewart Island.

There is no doubt of the availability of good kaolins in New Zealand from extensive deposits in Central Canterbury and North Auckland. The presence of quartz with extraordinary properties has been shown in many clays and is being further studied. Preliminary work upon the separation of felspar from deleterious minerals has shown that New Zealand mineral resources will always be ample for a New Zealand ceramic industry.

Less extensive work was carried out upon pottery plaster, ball clays, and the nature of the clays derived from greywacke.

Examination of a large range of samples of swelling bentonites from the Hawke's Bay area have not shown any of the deposits to contain more than 50 per cent.—and generally not more than 40 per cent.—of sodium montmorillonite, the active constituent, compared with 90 per cent. to 98 per cent. for the usual commercial material of foreign origin.

Processes.—Investigations were undertaken in the milling of ceramic materials and mineral dressing of certain raw materials.

Ceramics.—Fundamental work upon the parts played by felspar, quartz, and clay in porcelain and earthenware has progressed and revealed aspects of practical importance in the manufacture of these products. The new apparatus and techniques for small-scale laboratory work has demonstrated the value of the time spent upon this preliminary work.

Extensive literature surveys have been made and summaries issued for assistance of the industry.

Additional apparatus and test methods of value in research and process control in the industry have been prepared.

GENERAL

Assistance has been received from and given to sections of the Department of Scientific and Industrial Research, the Department of Industries and Commerce, the Standards Institute, and others.

A short critical survey of the New Zealand ceramic industry was undertaken in relation to production and technical efficiency.

Towards the end of the year the heavy-clay industry, comprising bricks, pipes, field tile, roofing tile, refractories, &c., had under active consideration the undertaking of co-operative research by an extension of the present Research Association.

A close liaison with overseas work and developments is maintained.

Lectures have been given by members of the staff and Technical Committee and many interim reports issued in addition to Technical Report No. 4, " China-clay (Kaolin) in New Zealand," by I. C. McDowall and W. Vose.

NEW ZEALAND WOOLLEN MILLS' RESEARCH ASSOCIATION (INC.)

Director: Professor F. G. Soper

Many applied research projects have been carried out or commenced during the year, and this involved in some cases practical work in various mills whose facilities have been placed at the disposal of the Association.

The Use of Anti-slip Agents in Worsted and Woollen Processing.—It has long been recognized in the wool-textile industry that the processing properties of wool are improved as a result of storage. This period of storage allows the oil that has been applied to the fibres to oxidize, and as a result gives increased inter-fibre friction.

During the year three mill trials have been conducted to examine the results of applying to wool Syton W-20 (a colloidal dispersion of silica) in water at the appropriate stages in worsted and woollen manufacturing. It has been found that the use of this anti-slip agent gives definite advantages in processing, such as the use of less twist and the elimination of storage, as well as enabling stronger and more extensible yarns to be produced.

The Effect of Spinning Twist on the Wearing Properties of Half-hose.—A range of half-hose was knitted using yarns of equal count but of varying twists. Abrasion tests have been completed using the Martindale wear-tester, and actual wearing trials are now being conducted to test the significance of the results obtained on the wear-tester.

Worsted Combing Oils.—For some time it has been felt that the oils being used in the worsted industry in this country are not entirely suitable. A preliminary trial has been made using a neatsfoot-oil with low free fatty acid content with satisfactory results, and a comparison of this oil is being made with olive-oil and with other oils at present used.

The Carding and Spinning of Wool and Rabbit-hair Blends.—During the year some time was spent in a mill putting through blends of wool and rabbit-hair on the woollen system. The cloths produced from these yarns were extremely soft-handling.

The Effect of Copper on Wool.—Copper sulphate is the only substance so far known to have any effect on mycotic dermatitis, a skin-disease of sheep. Experiments are being made to determine the maximum amount of copper compounds that can be tolerated in wool with respect to dyeing, bleaching, and the formation of stains.

Application of Fluorescent Bleaching Agents.—Experiments were made to find the best conditions for the application of these substances, and to determine their fastness properties.

Moisture Content of Wool.—Two devices for determining moisture content rapidly have been tested, one electrical and the other chemical. Neither was found to be very satisfactory for loose wool or top.

General.—In addition to work on the subjects mentioned above, a wide range of general testing and analytical work has been carried out.

RESEARCH INSTITUTE OF LAUNDERERS, DRY-CLEANERS, AND DYERS OF NEW ZEALAND (INC.)

Research Officer: Mr. P. C. Coates

During the year substantial progress was made by the Institute, and there has been a notable increase in membership.

A Research Officer was appointed, and he made himself familiar with the related industries and units in New Zealand before proceeding overseas to study technical developments and research methods of affiliated organizations in the United Kingdom, Canada, and United States of America.

A very successful two-day convention and exhibition was held in Wellington and attracted people connected with laundering and dry-cleaning from all parts of New Zealand. Among other features, a series of interesting technical addresses were delivered. The Institute was also represented at similar conventions in Australia and America.

Regular bulletins from overseas research establishments, together with other technical information, have been distributed to members, while specific problems were attended to with the assistance of the Dominion Laboratory and other organizations. Progress is being made in the setting-up of a laboratory in which the Institute will conduct long-range research, as well as attending to immediate problems.

CAWTHRON INSTITUTE

Director: Sir THEODORE RIGG

Aided by grants from the Department the Institute conducts several research projects, some of which are collaborative with those of the Department. Reports of investigations on fruit, plant nutrition, soils, and tomatoes appear below; that on entomology is included in the report of the Entomological Research Station appearing in reports from Branches; and those on hops and tobacco are included in the respective reports of Research Committees of the Council of Scientific and Industrial Research.

FRUIT RESEARCH

Magnesium Deficiency of Apples.—As the effect of previous applications of dolomite and magnesite on the apple experimental plots at Tasman and Lower Moutere was much less pronounced in the 1948–49 season than in previous years, fresh applications of these two magnesium compounds were made to many of the experimental plots in September, 1949. Very beneficial effects on the foliage of the apple-trees have resulted, and this indicates that on these soils more frequent applications of magnesium compounds are necessary to maintain healthy foliage and vigour of the trees. Magnesium determinations of apple-leaves from the past season's experiment have not yet been completed, but analyses of leaves made on the previous season's growth showed that the increase in magnesium resulting from earlier applications was not so great as was desirable.

Zinc Deficiency Tests.—The experimental plots established in the previous year to test the effect of zinc sprays on Gravenstein, Sturmer, and Jonathan apples on the Moutere Hills soil have been continued. Dormant zinc sulphate sprays were applied in August, 1949, to the same plots that received zinc sprays in the previous year. Observations have shown no effect from the sprays. Chemical analyses of leaves from the zinc experimental plots for the past season have not yet been completed, but zinc determinations of apple-leaves collected in the previous season from representative orchards in the Nelson district gave normal values of 25 to 30 p.p.m. zinc in the majority of cases.

Similar tests with zinc sprays were conducted in a cherry-orchard at Mariri, but here again no beneficial effect was noticed. The information from both field trials conducted on typical orchards on the Moutere Hills and from chemical analyses of leaf samples from four varieties of apples commonly grown in the Nelson district suggests that the zinc status of apple-trees in the Nelson district is on the whole satisfactory, and that little if any benefit is likely to result from the use of zinc sprays in the average orchard.

Copper Deficiency Tests.—The experimental plots established in the previous season have been continued, but owing to difficulties in cultivation, pruning, and spraying no significant result was obtained. There was a slight improvement in the foliage of the trees with copper sprays, but this was not

nearly so marked as in the previous season. Determinations of copper in apple-leaves collected from several orchards, including the experimental areas, showed contents of 10 to 18 p.p.m. for the most part. In certain orchards where copper sprays were used more frequently the figures were much higher.

Raspberry "Die-back."—Further field and laboratory work has been carried out to determine the cause of "die-back" in raspberry-canes. The disorder is common in many gardens in the Nelson district. Additional experimental plots to test the value of borax in the control of "die-back" were established during the winter of 1949, and determinations of boron were made on the soils of representative gardens and on both fruit and leaf samples obtained from the experimental plots and from other gardens in the Nelson district.

At Tadmor and Motupiko the experimental plots showed pronounced benefit from borax applications. Plots treated with borax came into leaf earlier than the control plots and were superior in both bud and leaf development. The beneficial effect of the applications was noticeable throughout the whole season, but in certain cases disease or the effect of other deficiencies obscured somewhat the outcome of the experiments. This was particularly so in tests carried out in a garden on granite soil at Orinoco. Borax applications to the bushes gave decided benefit in the early part of the season, but later in the season the effect did not appear to be so noticeable. As the bushes in this garden showed poor growth, it is suspected that other factors besides boron deficiency were operating.

Determinations of boron in both soil, fruit, and leaves of raspberry-gardens seriously affected with "die-back" at Motupiko and Tadmor gave low figures for this element, confirming the results obtained in the field trials. Water-soluble boron in the soils of affected gardens was usually less than 0·25 p.p.m., while the boron content of leaves from this season's fruiting canes was 20 to 30 p.p.m., compared with 50 to 60 p.p.m. for leaves from healthy gardens.

An interesting point emerging from the experiments was the beneficial effect of copper on the leaves at the experimental areas. The results suggest that copper sprays are desirable, not only for the control of diseases but possibly also for the nutrition of raspberries on certain soils.

Raspberry Manurial Trials.—Fertilizer experiments have been continued in two gardens in Tadmor Valley. In both cases the value of manures is clearly visible when treated plots are compared with the controls. At one garden the use of additional potash with the standard fertilizer gave increased benefit.

Mineral and Nitrogen Status of Apple-leaves from the Fertilizer Trials at the Appleby Research Orchard.—Samples of leaves collected from the Sturmer, Jonathan, and Cox's experimental plots in two different seasons have been analysed. Considerable differences have occurred in the analyses of comparable samples in the two seasons owing to differences in date of sampling, and this makes it desirable to analyse a further set of leaf samples before summarizing the analytical data. The results, however, are in keeping with the fertilizer history of the plots, and show well-marked reductions in phosphorus, potassium, and nitrogen where these elements have been omitted from the treatments—*e.g.*, Sturmer (untreated) gave 0·43 per cent. P_2O_5 in the leaves, compared with 0·76 per cent. for the plot receiving superphosphate only. Similarly, the nitrogen contents of leaves were 1·56 per cent. nitrogen (untreated), compared with 1·92 per cent. for the plot receiving sulphate of ammonia only.

Similar analytical work has been carried out for three seasons on the leaves of Dougherty trees manured in different ways at the Annesbrook Orchard. Pronounced differences in potassium and nitrogen levels resulted from the omission of these elements from the fertilizers used. The effect of phosphate omission on the phosphorus status of the leaves was not so marked as that quoted for Sturmer leaves at the Appleby Research Orchard.

Apple Stock Experiments at Annesbrook Orchard.—Tests of Double Vigour (French Crab vegetatively propagated) for the Statesman variety of apples continue to show to advantage over Northern Spy stock. The Statesman trees are now in their eighteenth year from planting. Total yields over the past five years are 711 lb. per tree for Northern Spy stock and 902 lb. per tree for Double Vigour stock.

Cox's Orange and Jonathan varieties on a vegetatively propagated stock derived from Epps' Seedlings have shown much greater growth than on Northern Spy stock. Yield of fruit is better with the Jonathan on the more vigorous stock, but the yield of Cox's Orange is about the same on the two stocks. The trees are now fifteen years old. The total fruit yields per tree for the past five years are: Cox's Orange-Northern Spy stock, 471; Epps' Seedling stock, 491; Jonathan-Northern Spy stock, 664; Epps' Seedling stock, 783.

" Die-back " in Cox's Orange Apple-trees.—An orchard at Redwood's Valley and one at Mapua have been included with the original Mariri orchard in this investigation. In the two additional orchards the range of fungi isolated from diseased trees is similar to that from the Mariri orchard, the descending order of frequency of occurrence being *Coriolus versicolor, Stereum purpureum,* and *Physalospora obtusa.* Bacteria have again repeatedly been found associated with infected tissues.

Gooseberry " Die-back."—An investigation of the cause of death of gooseberries in the Stoke and Richmond areas has shown that the fungus Verticillium (usually *V. dahliae*) is frequently present in roots and stem of diseased plants.

Raspberry Wilt.—The investigation already in hand in the Tadmor Valley has been continued.

PLANT NUTRITION

Boron Survey of Raspberries.—In view of the association of " die-back " of raspberries on certain soils in Nelson with low boron status of the bushes, and the paucity of data on the boron status of raspberries, it was thought desirable to analyse material from different parts of New Zealand.

Through the courtesy of the Department of Agriculture, samples of raspberry-leaves from this season's fruiting canes were obtained from Hastings, Havelock North, Greytown, Riccarton, Mosgiel, and Central Otago. Similar samples from Nelson gardens were obtained for comparison. Fifteen leaf samples from centres outside Nelson gave an average boron content of 58·5 p.p.m. Omitting two samples from Hastings which were very high (109·3 p.p.m. boron) and two from Central Otago which were low (24·8 p.p.m. boron), the average boron content of the remaining eleven samples was 55·4 p.p.m. This figure compares favourably with that obtained from healthy gardens in the Nelson district (40 to 50 p.p.m. boron). Eleven samples from the Motupiko, Tadmor, and Sherry localities of the Nelson district gave an average boron content of 29·3 p.p.m. Gardens badly affected with " die-back " gave boron figures of 20 to 25 p.p.m.

The survey has definitely shown that the boron content of raspberry-leaves in many Nelson gardens, and in certain gardens in Central Otago, is approximately 50 per cent. of the average boron figure of all leaf samples so far tested.

Zinc, Copper, and Manganese Contents of Raspberry-leaves.—Estimations of zinc, copper, and manganese were made on many of the leaf samples collected for the boron survey. The figures for these elements varied greatly for different leaf samples, particularly with manganese, where the content occasionally rose to over 450 p.p.m. Some instances of relatively high copper contents were probably connected with the use of Bordeaux sprays. The zinc contents were usually restricted to a small range of values, except for two leaf samples from Hawke's Bay.

The average figure for zinc in raspberry-leaf samples collected from twenty-one gardens, mainly located in the Nelson district, but including samples from other parts of New Zealand, was 58·7 p.p.m. The range of zinc content was from 13·8 to 189·5 p.p.m., with the majority of the samples about 30 to 50 p.p.m.

The average figure for copper in sixteen leaf samples was 14·8 p.p.m. The range of copper figures was 6·2 to 37·0 p.p.m., with the majority of samples falling between 10 and 15 p.p.m.

The average figure for manganese in sixteen samples of raspberry-leaves was 256 p.p.m., but the range was very great (67 to 480 p.p.m.) on different samples. Adjoining gardens even showed great variation in some cases.

Intake of Plant Nutrients by Glasshouse Tomato-plants.—To obtain information on the manurial requirements of glasshouse tomatoes, a plot of tomatoes grown on sterilized soil and manured with a standard fertilizer mixture was reserved for plant analysis.

Four examinations were made during the development of the tomato-plants commencing on 27th October, 1949, and concluding on 26th January, 1950. On each date of sampling the same number of plants was removed and separated into leaves, stalks, and fruits. Records were taken of both green and dry weights of the component parts and analyses were then made for the content of plant nutrients. As a result of this work it is possible not only to record the nutrients status of the plants on the 26th January but also to show the quantities taken in by the plants at four periods during the development of the plants and the fruits.

Each ton of tomatoes grown on the experimental plots would have contained 103 lb. of dry matter, and associated with the production of 1 ton of tomatoes there was 26·4 lb. of dry matter in the stalks and 40·3 lb. of dry matter in the leaves—*i.e,* the production of 1 ton of tomatoes was associated with a total dry-matter weight of tomatoes, stalks, and leaves of 170 lb. The analyses calculated from the last examination (26th January, 1950), showed that the total intake of nutrients by tomato-plants per ton of fruit was: phosphoric acid, 1·742 lb. (fruit, 0·994; stalks, 0·277; leaves, 0·471); potash, 8·071 lb. (5·911, 1·210, 0·950); and nitrogen, 3·751 lb. (2·245, 0·411, 1·095).

Based on these figures, a 60-ton crop of glasshouse tomatoes, which is considered a satisfactory yield under Nelson conditions of culture, would require for the full developments of the plants and the crop not less than 523 lb. superphosphate, 970 lb. sulphate of potash, and 1,125 lb. sulphate of ammonia or other equivalent nitrogenous fertilizer. These figures are lower than those reported from overseas experiments, and it may well prove that, for optimum yield and the highest quality of tomatoes, larger quantities of fertilizers than those enumerated above are desirable for Nelson conditions.

Mineral and Nitrogen Status of Hop-plants.—A considerable number of samples of hop leaves and cones have been collected with a view to checking the low potash status of many hop soils in the Nelson district, and to secure information about the effect of fertilizers on the mineral and nitrogen status of the hop-plants and of the cones. Dry-matter determinations have been made on a number of the hop-cone samples, and show a range of values from different gardens of 18·1 to 25·8 per cent. The majority of the samples contained 22 to 23 per cent. of dry matter. Chemical analyses of the leaf and cone samples will be carried out during the coming winter.

SOIL INVESTIGATIONS

Reconnaissance Soil Surveys.—In co-operation with the Soil Bureau of the Department, a reconnaissance survey of soils in the Collingwood County was made. Assistance was also given to the Soil Bureau in reconnaissance soil surveys of the Sounds district and the Upper Wairau and Rainbow localities.

Tobacco Soil Surveys.—The mapping of tobacco soils in the lower Dove and Baton Rivers was completed, and maps have been prepared showing the distribution of soils in this locality. A paper has been prepared giving a description of the tobacco soils in the Waimea County, and the total usable acreages of the four categories (very good to satisfactory). A careful consideration of the data compiled during the surveys suggests that it would be unwise to increase the average annual acreage of flue-cured tobacco in the Waimea County beyond 6,000.

Reclassification of Soils in the Waimea and Takaka Counties.—This work has been commenced in order to bring the soil maps of these counties in line with those prepared by the Soil Bureau in other parts of New Zealand. The reconnaissance soil maps of these counties made by the Institute many years ago have been used as a basis for the reclassification, and have saved a great deal of time in mapping. Field-work has been completed except for the checking of information resulting from the chemical examination of soil profiles. The field work has shown the necessity for the subdivision of the Moutere Hills soil into several distinct types owing to differences resulting from different degrees of leaching or from the influence of cyclic salt.

With the exception of "recent" soils of the river valleys and the "skeletal" soils of steep hills, the majority of the soils in the Waimea and Takaka Counties belong to the "yellow-brown earth," already identified by the Soil Bureau in other parts of New Zealand where the rainfall is between 30 in. and 60 in. per annum.

Land Utilization.—Work will be commenced on land-utilization studies on the various types of Moutere soils in the Waimea County as a guide to the optimum use of such land for various forms of agriculture—*e.g.*, forestry, general farming, and horticultural uses.

The importance of formulating sound proposals for the future utilization of the Moutere soils is recognized, and the Lands and Survey Department has agreed to facilitate the preparation of base maps for the required studies, while the Institute undertakes the necessary soil and land use studies. The data already available shows that the total acreage of Moutere soils is approximately 285,000, the land being subdivided into the following categories: existing native forests, 32,000 acres; land in bracken and scrub (required for protective forests), 31,000 acres; planted to *Pinus insignis*, 50,000 acres; and available for agriculture, orcharding, and extension of pine plantations, 172,000 acres.

The proposed studies will be concerned mainly with the 172,000 acres of land that is nominally used for agriculture but which, in certain localities, is of very low value for farm purposes.

Chemical Investigations.—Work in the soil laboratory has been concerned with the examination of tobacco, hop, and raspberry soils in the Waimea County, and the study of profile soil samples collected during the reconnaissance surveys of Waimea and Takaka soils.

Tobacco Soils.—Some fifty soil samples from the Wai-iti and Waimea districts have been examined for exchangeable bases. One of the interesting points emerging from the analyses was the high figures for exchangeable magnesium obtained in soil samples from the Waimea district. In certain cases exchangeable magnesium was as high as 9 milligram-equivalents per cent. MgO.

Hop Soils.—Over one hundred soil samples from hop-gardens in the Nelson district were examined by "quick tests" for available phosphoric acid and potash and for pH values. The results of these examinations are summarized under "Hop Research" in the reports of Research Committees.

Raspberry Soils.—The main feature of the chemical work was a survey of water-soluble boron in representative soils used for raspberry culture in the Nelson district. The survey showed that the soils varied in boron content from 0·08 to 0·55 p.p.m. Gardens affected with a "die-back" of canes, more fully discussed under "Fruit Research" (p. 93), had water-soluble boron contents in the soil of 0·08 to 0·22 p.p.m. Gardens that were apparently healthy showed a considerable range in boron contents from 0·25 to 0·55 p.p.m.

The influence of borax applications in raising the boron content of the soil and the effect of dolomite in reducing water-soluble boron figures was quite marked.

Estimation of Molybdenum.—A method for the colorimetric estimation of molybdenum has been devised, giving an 80 to 85 per cent. recovery of added molybdenum. A survey of molybdenum in representative soils in the Nelson district is now being made.

TOMATO INVESTIGATIONS

Tests with Steam and Soil Disinfectants.—Steam, chloropicrin, D-D, a mixture of chloropicrin and D-D, and Sterizal were tested under glasshouse conditions.

Steam treatment of the soil again gave excellent growth of tomato-plants, accompanied by high yield of fruit. Chloropicrin used for the fourth year in succession also gave healthy growth, but the yield was slightly below that with steam treatment. D-D used for the third year in succession again gave a satisfactory result, but the plants were not so uniform as those with steam or chloropicrin treatment, and yield was somewhat lower. This year, probably owing to drier soil conditions, there was no pronounced flavour of the tomatoes resulting from the use of D-D. Where additional cultivation was given to D-D treated plots, further reduction in distinctive flavour occurred. Sterizal under the conditions of the experiment gave less healthy growth of the plants and lower yield.

Typical yields from the different treatments are: unsterilized, 4·5 lb.; steam, 9·5 lb.; chloropicrin, 8·7 lb.; D-D, 8·2 lb.; chloropicrin and D-D mixture, 8·5 lb.; Sterizal, 6 lb. per plant. The best quality of tomatoes was obtained from the unsterilized and the chloropicrin-treated plots; Sterizal gave the poorest quality, and steam and D-D treatments gave an intermediate quality.

An examination of the roots of the tomato-plants at the end of the season showed healthy clean white roots with steam treatment. Chloropicrin plots likewise gave healthy roots, but some root-knot eelworm was present. In the D-D treatment, the development of roots was similar to steam but there was some discolouration; plants on the unsterilized and on the Sterizal plots showed decayed and badly discoloured roots with little fibrous development.

Value of Compost, Sawdust, &c., for Glasshouse Soil.—Experiments have been continued to ascertain the value of compost, sawdust, and cocoa-bean husks in the treatment of glasshouse soil. Compost used at 15 tons per acre for the fourth successive season again gave the highest yield. Sawdust applied at 30 tons per acre in the 1945 season gave this year a slightly higher yield than that of the control plot. Cocoa-bean husks used on unsterilized soil at 15 tons per acre for the fourth consecutive season again gave a considerably higher yield than that of the unsterilized plot without cocoa-bean husks.

Typical yields for the above treatments are: sterilized soil with compost, 10·4 lb.; sterilized soil with sawdust, 9·8 lb.; sterilized soil (control), 9·5 lb.; unsterilized soil, 4·5 lb.; and unsterilized soil plus cocoa-bean husks, 6·5 lb. per plant. Quality of tomatoes was best on the unsterilized plots. The use of compost and sawdust gave a somewhat lower percentage of first-grade fruit than with steam only.

Effect of Heavy Potash Applications on Quality of Tomatoes.—Last season mention was made of a marked improvement in quality of tomatoes where heavy applications of potash (1 ton per acre) had been made each season for several years. Further confirmation of the importance of potassic manures in improving quality of the tomatoes on Nelson soil has been obtained in the past season's experiments. Very heavy dressings of muriate of potash steadied growth, reduced yield, and improved quality of the tomatoes. The yield per plant and percentage of first-grade tomatoes from plots treated with massive doses of potassic manures in one of the glasshouses were: control, 9·5 lb. per plant, 37 per cent. first-grade tomatoes; extra potash (1 ton per acre for several years), 8·9 lb., 57 per cent.; extra potash (4 tons per acre one season only), 7·7 lb., 63 per cent.; and extra potash (4 tons per acre one season only, plus extra nitrogen), 7·5 lb., 68 per cent. All plots were steamed and manured with Standard fertilizer. Similar improvements in quality of tomatoes was obtained with larger applications of potash in two other glasshouses.

Effect of Late Planting on Yield and Quality of Tomatoes.—For the second consecutive season a plot of tomatoes was planted on 7th October to compare growth and fruit characteristics with those planted at the normal time in August. The late-planted tomatoes were approximately three weeks later in maturing, but the yield this season approached more closely that from the August-planted tomatoes, the yields being 9·7 lb. and 10·4 lb. per plant respectively. The quality of tomatoes on the late-planted plot was superior to that of the August-planted plot, but the difference was not so pronounced as that obtained in two previous seasons.

Effect of Glasshouse Heating on Yield and Quality of Tomatoes.—A compartment of one of the glasshouses was heated during the early part of the season when night temperatures frequently were low. The period of heating extended from time of planting, 18th August, until the end of September. When the minimum night temperature in the unheated portion of the glasshouse fell below 50°F. the heated section rose about 10°F. above the unheated section of the house. Under the more uniform temperatures of the heated compartment the tomato plants established themselves more quickly

and growth was more vigorous and of softer appearance. Despite the more vigorous growth in the early part of the season, there was little difference in the date of maturity of the heated and unheated sections of the glasshouse. Yield of tomatoes in the heated section of the house was about the same as for unheated conditions, but the quality was rather better. The results of the experiment suggest that under the particular climatic conditions of the past season, and the glasshouse management adopted, low temperatures at night during the early part of the season did not affect very greatly maturity, yield, or quality of the crop.

"*Hard-core*" *Investigations.*—Work has been continued on different aspects of the "hard-core" investigations. The beneficial effect of heavy dressings of potassic manures was confirmed in the past season's experiments; both 1 ton and 2 tons of muriate of potash per acre when used in conjunction with the Standard fertilizer resulted in a great reduction in the amount of "hard-core." The tomatoes grown on the plots treated in the previous season with a heavy application of lime did not show any improvement in quality this season.

Chloropicrin treatment of the soil again proved very effective in reducing the amount of "hard-core" in plants receiving the Standard fertilizer.

Tests with minor elements did not significantly affect either yield or quality of the tomatoes.

UNIVERSITY COLLEGES

Grants were made by the Department to Canterbury and Massey Agricultural Colleges and to Canterbury University College.

CANTERBURY AGRICULTURAL COLLEGE

AGRICULTURAL LIMESTONE

Mr. B. L. Elphick

Solubility of South Island Limestones.—A study of the rate of solution of twenty-five South Island agricultural limestones in the soil in relation to fineness of grinding and other physical properties has been completed. A preliminary survey of thirty-seven limeworks revealed great diversity in the hardness, porosity, and purity of the limestones. Purity ranged from 50·5 per cent. to 99 per cent. carbonate, and porosity from 0·3 per cent. to 50 per cent. Canterbury and Southland limestones were lowest in purity, each averaging about 75 per cent. carbonate. Magnesium and phosphate content were uniformly low. Of the commercial samples tested, 80 per cent. were of a satisfactory fineness.

Twenty-five limestones were tested for their progressive solubility in the soil at various finenesses of grinding. The most striking feature of the results was the small effect exerted by the differences in hardness and porosity. Fineness of grinding exerted ten times as great an effect, and it is concluded that a slight increase in fineness would make the hardest stone as soluble as the softest. Material of 10–20 mesh dissolved (in the soil) at a useful rate: from 26 per cent. to 38 per cent. in six months. A fairly good correlation was found between the measured solubility and various physical properties of the limestones.

Pasture Top-dressing Trials.—A commencement has been made on top-dressing trials to compare solubilities of the limestones under Canterbury pasture conditions and to test the interaction of the four factors—type of limestone, fineness of grinding, rate of application, and soil type—with a view to determining the most economical rates and frequencies of application under different conditions, and to measure the leaching loss on different soil types.

Bulk Storage.—A trial on the open-air stock-piling of three types of commercial crushed limestone has revealed that damp limestone can be satisfactorily spread with certain kinds of bulk distributor. This offers the possibility of cheap storage for accumulated stock-piles of agricultural limestone.

Soil Acidity and Crop Growth.—Fifty farm and garden crops have been grown for the second season in soil adjusted to different reactions, ranging from mildly alkaline to strongly acid. Owing to dry seasons the acidified soils still retain sufficient calcium to promote normal growth of most species.

ANIMAL HUSBANDRY

Professor I. E. Coop

Sheep Projects: Progeny Testing.—In the Corriedale merit sire tests the results of the first test were published. In the second test no Merit Certificate was awarded as no ram was successful in fulfilling the conditions. The third test, for which eleven rams were nominated, was commenced in April, 1949. The progeny to these rams have been graded for breed type and the wether lambs have been slaughtered for the measurements of carcass quality. The ewe lambs have been carried over and will be shorn during October, 1950, to provide the fleece evaluation for the test. The fourth test was commenced in March, 1950. Ten of the rams nominated were accepted. Hand service, a departure from the normal tupping procedure, was adopted this year to provide critical data of the breeding behaviour of the ewes.

Progeny testing in one privately-owned Romney stud flock and Corriedale flock has been continued. In addition to providing a basis for the breeding programme, the information now available includes lifetime fleece-production of ewes, together with the effects of season and single and multiple births on the fleece of the ewe.

Pig Projects.—Large White × Tamworth (Lincoln Red) was continued with pigs of the new F1, F2, F3 generations, together with the earlier red pigs. Six pigs from five different sows were exhibited in the "Bacon Carcass Competition" conducted by the Canterbury District Pig Council. Four of these pigs were exhibited in the special "Recorded Class," and were placed first (two, both with 86 per cent. of possible points), second (85 per cent.), and third (80 per cent.). The two other pigs were entered in the "Carcass Class" only and scored 89 per cent. (second prize in a class of 184 carcasses) and 68 per cent. of the possible points.

Selection and breeding within the strain is being continued.

Wool Department.—A further year's results of the progeny testing of rams in two commercial studs have been obtained. In a Merino stud the fleece characteristics alone are measured, whereas in a Romney stud fleece, the carcass conformation and breed type are all measured.

The wool survey has now been reduced to one flock, a Romney flock in which the ewes are shorn before lambing. The analysis of past results of wool surveys in forty-four different flocks over several years is being completed, so that some general conclusions may be reached on whether wool surveys should be continued or stopped.

ENTOMOLOGY

Mr. L. Morrison

Hessian Fly.—Seasonal observations were continued, but once again the area studied was too restricted to be of full value. This was especially so this season, since the distribution of Hessian fly was very uneven.

Insect Fauna of Red Clover.—The investigation was continued with special reference to the red clover thrips, and indicated that this pest is not of any economic significance.

Porina Investigations.—Further progress was made in determining the effect of different levels of temperature and humidity on the period of incubation and percentage hatch of eggs of Porina moths.

FARM MACHINERY RESEARCH

Mr. A. W. Riddolls

Small Seeds Harvesting.—During the 1948–49 harvest trials were made of harvesting white-clover seed to obtain a comparison of yields of seed per acre obtained when a medium to light crop was cut with a 6-ft.-cut mower fitted (*a*) with standard outside swath board only and (*b*) with two swath boards of special design. The resulting windrows were picked up and threshed with a header harvester. The results of these trials, which were made on a series of sixteen randomized plots, have now been analysed. These show an average yield with method (*b*) that is 37 per cent. greater than with method (*a*), and this confirms the results of similar trials made in 1947–48. These results indicate that, in medium to light crops of white clover, yields will be significantly increased by the use of the two outside swath boards of special design, compared with the single outside swath board. Twenty-nine further trials were made on damage to white-clover and red-clover seed by varying header harvester drum speed and drum clearance. Although damage of up to 10 per cent. was recorded, and a trend to greater damage with closer drum setting and higher speed was shown, inconsistencies were noted, which indicate that a specially built experimental machine is required. This would allow all possible factors in seed damage to be varied rapidly, and also allow a large number of samples to be taken in a short time.

Mechanical Ditch-cleaning.—The tractor-mounted ditch-cleaning machine, built and tested in 1948, has been completely redesigned and rebuilt as a result of experimental work carried out with the original machine, and trials with the new machine are proceeding.

MICROBIOLOGY

Mr. H. T. Wenham

Bacteriology.—A survey of the occurrence of potentially pathogenic bacteria in farm milk samples is continuing and 286 samples from 168 different suppliers have been tested.

The study of lysis of acid-fast and other pathogenic bacteria in the lymph of wax moths is now in its third year. Of particular interest is varietability noted in the digestion of cells of *Mycobacterium* with loss of some ability to retain acid-fast stains.

Soil Microbiology.—Techniques relating to the study of soil Actinomycetes have been developed, and microfloral changes associated with boron and fertilizer applications to the OMU suite of soils, Auckland, have been traced. Morphological descriptions and physiological studies have been made on isolates of Actinomycetes. Antibiotic activity has been demonstrated, especially with *Actinomycetes dermatonomous* from lumpy wool.

Plant Pathology.—Laboratory and field studies of speckled-leaf blotch of wheat and the causal organism (*Septoric tritici*), including host range studies, have been completed. Results indicate the pathogen to be highly specialized in this country, being confined to wheat. Field and glasshouse trials with twenty New Zealand wheat varieties have yielded no resistant varieties.

Investigations on powdery-mildew of wheat (the life history, incidence, and host range of the fungus *Erisiphe graminis tritici*), have been carried out, including a study of the infection types on immune, resistant, and susceptible wheat varieties. Over 174 wheat varieties selected from the Wheat Research Institute collection were recorded for mildew infection with two races of the wheat mildew present in New Zealand.

PASTURES ON LIGHT LAND

Mr. J. W. Calder and Mr. C. E. Iversen

The annual fertilizer treatments were continued on the established subterranean-clover stands in series " A " (5 cwt. of lime and 1 cwt. of superphosphate in alternate years) and in series " B " (2 cwt. of superphosphate annually). Seasonal production was measured by means of protected quadrats. Series " A " produced 1,217 lb. of dry matter up to 31st January, and series " B " produced 1,046 lb.

The newly-sown pasture mixtures in series " D " (sown February, 1948) and those in series " C " (sown February, 1949) performed reasonably well considering the extremely dry season. The production from the " D " series—second-year pasture—averaged about 100 per cent. more than the established subterranean-clover pastures in series " A " and " B."

Of the different pasture mixtures, those which were predominantly ryegrass—both first- and second-year stands—produced considerably more than those which were predominantly cocksfoot or phalaris.

SOIL FERTILITY

Mr. H. D. Orchiston

The long-term soil-fertility project initiated in 1946–47 has been carried forward. The objective is to study (1) the interaction of the soil and the wheat crop as influenced by four rotations designed to produce different levels of fertility; (2) the effect of four cultivation treatments for seed-bed preparation; and (3) the effect of eight fertilizer treatments.

All crops established well, but yields were low as a result of a very dry season. Significant differences within and between rotations were recorded, but not between cultivation and fertilizer treatments.

VETERINARY DEPARTMENT

Progeny Testing in Sheep.—The final analysis and interpretation of the data collected over three years in the progeny testing of Southdown rams is almost completed. Differences in birth weight, rate of growth, dressing percentage, and carcass conformation and composition have been established, and other useful data assembled.

Sheep-dipping Mortality.—The final report of the investigation into "lameness" following dipping in rotenone-bearing powders and benzene hexachloride has been published. This investigation laid the foundation for the final elucidation of the condition shown by others to be an infection of wounds by *E. rhusiopathiæ* from dipping washes that contained no bacteriostatic agents.

Methods of Tailing and Castrating Lambs.—The final report of the investigation dealing with the use of rubber bands for castration has been published. From the point of view of growth rate, no superiority of the method could be shown, and there was evidence that the method predisposed to tetanus infection.

CANTERBURY COLLEGE INDUSTRIAL DEVELOPMENT DEPARTMENT

Director: Mr. T. R. Pollard

This department of Canterbury University College was formed in October, 1948, and the report, covering the first complete year of operation, shows a rapidly increasing use of its services. There have been 320 jobs for industrial organizations, 140 for Government Departments, and 564 for other sections of the College. The year has shown the completion of the extensions to the buildings, and this has given a considerable improvement in the accommodation for the design staff.

It has been found necessary to develop a certain amount of test apparatus to enable industrial work to be handled in a reasonably economical manner. It has taken time to get the experience of just what is required in the industrial field, but technique and apparatus are being built up, and it is expected that a considerable increase in the industrial work will be shown during the forthcoming year.

Considerable assistance has been given by various branches of the Department of Scientific and Industrial Research, especially the Dominion Laboratory (chemical engineering section), which has co-operated in a number of investigations, and the Industrial Liaison Officers of Christchurch and Dunedin have initiated a number of projects. Other sections of the college, particularly the Chemistry and Mechanical Engineering Departments, have also been of much assistance.

MAIN PROJECTS

Some of the major projects undergoing investigation are as follows:—

Rabbit Fumigator.—Research and development work on this is now complete and the Rabbit Destruction Council has been advised to place an order with a local firm for a small number of these fumigators, which can be tried

out in the high country. A fairy comprehensive report covering the experimental work in connection with the killing of rabbits by toxic gases is in the process of being issued.

Tentering-machine.—The construction of a tentering-machine for the Disabled Servicemen's Association is well under way, but a certain amount of difficulty is being experienced in finding enough space to assemble the unit. Designs are proceeding for the development of a blowing-machine for the same organization. This unit is to work in conjunction with the tentering machine, and is to be used for the pressing of the fabric after it comes off the tentering-machine.

Investigation of a Hydraulic System.—Relief valves have been fitted and the accumulator trip mechanism is completed and installed.

Audiometer for the Auditory Testing of Small Children.—The apparatus is completed, and is being tested before being handed over to the Speech Therapy Association.

Investigation of Cistern Castings.—This investigation was done in conjunction with the Dominion Laboratory, and the root of the trouble leading to poor galvanizing has now been cleared up.

Pre-determined Counter for Gross Lots of Cable-clips.—Developed for a Christchurch firm, this instrument uses a photo-electric cell, and its function is to sound an alarm and stop the machine each time 144 operations are carried out.

Annealing-furnace for Press Contacts.—This is a processing furnace and holds batches of clips at a predetermined annealing temperature for a definite period. This is completed and is now undergoing tests.

Air-temperature Control for Octane-rating Engine.—After a delay of some months awaiting the arrival of transductors from an Auckland firm, the unit is now complete and is being tested.

Coding Switch for Navigational Beacon.—Completed and delivered to the R.N.Z.A.F. at Wigram. Flying tests, it is expected, will take place shortly.

Gramophone Audiometer.—This is a piece of apparatus designed to enable the bi-aural hearing facilities of aircraft of R.N.Z.A.F. air crews to be tested under conditions of aircraft noise. The job has been completed and is undergoing tests, and will be handed over in a few days to the R.N.Z.A.F.

MASSEY AGRICULTURAL COLLEGE

MANURING TRIAL UNDER ROTATIONAL GRAZING

Mr. A. W. Hudson and Mr. C. V. Fife

This experiment is a continuation of the original grazing trial that was carried out to determine the effect of different manurial treatments on the thrift of sheep. The manurial treatments have been continued in order that a long-term study may be made of the influence of the applied fertilizer treatments on the soil and the movement of applied nutrients. A detailed study has been made of the forms in which phosphate is fixed in the soil, and these results are now being prepared for publication.

SHEEP HUSBANDRY RESEARCH

Mr. R. A. Barton

At the conclusion of the trial of pedigree perennial rye-grass as compared with short-rotation rye-grass, the area was used for a study of fat-lamb and wool production at two different rates of stocking. Conjointly with this an investigation was also commenced of the effect of Southdown rams of widely differing type as fat lamb sires. The experiment commenced in the autumn of 1948 and is planned to continue for four years. One group of ewes was stocked at the rate of five ewes per acre and a second group at the rate of seven ewes per acre. Two "good" quality Southdown rams and two "poor" quality Southdown rams were mated with these ewes. Preliminary results indicate that the progeny of the "poor" quality rams were inferior to those of the "good" quality rams in shape of leg, subcutaneous fat cover, possible rate of maturity, and export grade. The progeny of the "poor" rams were longer in the leg and in general lacking in carcass quality. The effect of plane of nutrition cannot be determined from one season's results, due to seasonal influences.

Mr. H. Goot

Further tests have shown that the photo-electric wool staplemeter for measuring tippiness of wool staples has a satisfactory degreee of accuracy and speed. Several overseas countries have shown considerable interest in the possibilities of the new instrument, and full descriptions have been published.

The analysis of data accumulated by the fleece-testing department has been continued, and four papers giving the results of these analyses have been published. The work commenced in 1947 on the changes in body weight at different stages of development of sheep and the effect on these changes of different sires, dams, season, &c., has been continued. Over five hundred lambs on a commercial stud-sheep farm are being weighed at approximately two-monthly intervals from birth till fourteen to eighteen months old. They are also graded for "fleshing" at each weighing. The results indicate that there is a highly significant correlation between body weight and fleece weight in Romney lambs. In the 1947 crop of lambs there were highly significant differences between the birth weight of singles and twins and between male and female singles. Differences due to age of dam were highly significant for twins and female singles. A marked depression of the rate of growth after weaning was observed. There was a highly significant correlation ($r = + 0{\cdot}22$) between the age of lambs and the rate of growth.

Mr. A. L. Rae

The data derived from past years' work are being analysed by Mr. Rae while studying for a Ph.D. degree at Iowa State College, U.S.A. It is becoming apparent from analyses of data that a satisfactory progeny-testing programme for commercial stud-sheep breeding is full of difficulties. These data, however, enable estimates to be made of the strength of inheritance of various characters which should be of value to sheep-breeding when applied as selection indices and especially so when more data are available. As the result of past work dealing with progeny testing under a random mating system, it is intended to investigate the possibility of more encouraging progress being made when specific combining ability plays a part in producing more desirable progeny.

ANIMAL NUTRITION PROJECTS

Dr. C. R. Barnicoat

Milk-yield of Romney Ewes.—The experiment involves a systematic annual recording of milk-yields of over thirty ewes held at the college farm from the two-tooth to five-year-old stage. The experiment is designed to ascertain whether ewes are persistent milkers from season to season, the effect of age on yield, and the effect of twinnings on yield.

A convenient and reliable method of estimating the milk-yield of ewes consisted of recording the increase in weight of lambs allowed to suckle the ewes six times during a twenty-four-hour period. A reliable method of sampling ewes' milk for analysis was also worked out. It was found that the age of the ewe, date of lambing, health of ewe, number of lambs suckled, genetic factors, and plane of nutrition all influenced milk-yield. By controlling the plane of nutrition it was determined that feeding of the ewe during pregnancy had an important effect on maintaining yield of milk during the latter part of lactation. Feeding during lactation was a primary factor influencing both initial and total milk-yield, and liberal feeding during late pregnancy and throughout lactation produced maximum milk-yield.

The composition as well as the yield of milk vary widely with individuals. Ewes' milk increased in solids-not-fat during lactation and milk from older ewes was richer than that from younger animals. The lowering of the plane of nutrition of ewes caused a decline in the protein and ash content of the milk as well as a decline in milk-yield. The milk of these animals was, however, richer in fat.

It was shown that there was a relationship between rate of growth of lambs and the milk-production of the ewe. The greatest effect was observed when the lambs were between four and six weeks old. At later ages the effect of milk-yield was reduced by the consumption of grass. In spite of this, it was found that for the lactation as a whole the growth of the lamb was increased by increased milk-production of the ewe.

Wear in Sheep's Teeth.—Visits were made to ewe fairs and farms. Over five hundred five-year-old ewes on eleven farms in the Taihape area were mouthed and a selection photographed. Further observations were made of the effect of "soft" pastures producing wear of grazing sheep. The effect of over-stocking is being followed with sheep on the Te Awa area and on a block at Massey College. Rate of eruption and wear has been followed with incisors of over thirty ewes.

Several factors appear to be concerned in wear of sheep's teeth: (*a*) shape, size, and setting of teeth, which is probably a hereditary characteristic; (*b*) the abrasive effect of pastures and/or silt, worm casts, &c.; (*c*) rate of stocking; (*d*) climate as affecting pasture, and (*e*) plane of nutrition as affecting use of teeth.

ROMNEY × CHEVIOT CROSSBRED SHEEP EXPERIMENT

Professor G. S. Peren, Mr. W. R. Hewitt, and Mr. T. O. Phillips

The work is designed to collect from farmers breeding Cheviot/Romney sheep, in selected areas, information on the usefulness of the cross in marginal sheep country and to contrast returns from the use of cast for age ewes of this cross as mothers of Southdown cross lambs with returns from the standard Romney/

Southdown cross. Present indications are that the Cheviot/Romney can fill a very useful place in the sheep industry of the North Island. It remains to be learnt by more continued use of the Cheviot whether this early advantage will be maintained.

Cast for age Cheviot/Romney ewes have so far produced a higher percentage of lambs at birth and slaughter than the Romney ewes, and the carcasses of the lambs when fat weigh and grade equally. This apparent financial gain of the Cheviot/Romney cross is slightly offset by the lower return from the sale of wool from the ewes. Since the beginning of the trial, however, the Cheviot/Romney cross ewes show a net advantage.

FARM DRAINAGE

Mr. A. W. Hudson and Mr. H. G. Hopewell

Considerable diversity of opinion exists concerning the efficiency of mole drains pulled with plugs of various sizes. A trial has therefore been commenced using plugs of 2 in., 3 in., and 4 in. in diameter. Preliminary observations during the first year showed that flows were best from the 4 in. plug and poorest from the 2 in. plug, but no final conclusions will be possible for several years.

A trial, commenced in 1940 to investigate the effect of pulling mole drains at depths of 16 in., 19 in., and 22 ins., has shown that shallow mole drains are more efficient during their effective life, which, however, is much shorter than for deeper drains.

In 1948, moles were pulled with blades of varying thickness. Earlier work had shown that a blade 1 in. thick hastened the entry of water into the mole but also hastened breakdown. The experiment has therefore tested the use of a modified blade 1 in. wide to a point about 2 in. above the torpedo, and observations during the first season show a slight advantage in favour of the modified blade over the standard one.

Other experiments on mole draining are designed to study the relative efficiency of different methods of connecting minor mole drains to major mole drains or to tile drains.

An experiment to investigate the effect of various methods of backfilling the trenches on the efficiency of tile drains has shown no marked differences between treatments. Drains covered with a layer of straw have tended to give highest maximum and total flows on most occasions. From the results there appears little evidence so far to justify the added expense of placing porous materials over tiled drains in soils with a moderately clayey subsoil.

Other drainage trials are concerned with comparing the carrying-capacity and thrift of stock on an undrained as opposed to a drained area; a study of methods of preventing the silting of tiles on a sandy or silty loam; a comparison of concrete and baked earthenware tiles; and a trial to determine the effect on efficiency of tile drains of various methods of laying tiles in the trench.

PROPAGATION RESEARCH

Dr. J. S. Yeates

Tip-grafting.—This technique has been tested under various conditions in order to evaluate it for grafting when the wood of stock and of scion are at various degrees of ripeness. The results have shown that, in general, success depends on either or both stock and scion wood being from very soft to half-ripe or fully ripened, according to the precise species of plant involved. This method of grafting is proving very successful for the more difficult species, and is now being used increasingly in the nursery trade.

Budding of Rhododendrons and Camellias.—A considerable amount of work was carried out on different styles of budding. These plants are not normally budded, and it was hoped to evolve a satisfactory method. It was eventually found that buds could be successfully inserted, provided the accompanying leaf blade or a part of it was retained on the bud. The subsequent growth of the buds has not been satisfactory and further work is necessary.

Rooting Trials.—(*a*) *Azalea mollis:* A large number of cuttings of this plant have been inserted under a range of different conditions in an attempt to overcome the difficulty in rooting them. The current trials are not yet far enough advanced for any conclusions to be drawn. (*b*) *Daphne:* Further trials have been set out of this important export nursery crop. The use of a wider range of rooting hormones, and other treatments are included in the trials. (*c*) *Camellia and Other Plants:* These trials, being run parallel to those on daphne, are designed to provide information on which a series of bulletins or leaflets can be written when a detailed study has been made of the main factors involved.

Trials of Hormones, &c.—This work, which is carried out partly on the plants mentioned above and partly on other plants, is aimed at evaluating the different hormones and other rooting aids, and also at finding some correlation between plant reaction and any other factors. A fairly wide range of hormone compounds has been used in these trials, which will need a considerable time for completion.

NEMATODE PARASITISM IN SHEEP

Mr. J. H. Tetley

Estimating the Date on Which Parasites are Acquired.—Sheep reared free from parasitism were exposed to parasitism over three-week periods during the summer in a previous year and then killed. By estimating the ages of the parasites it was possible to an extent to work back and determine the dates when the parasites were acquired. In order to confirm the accuracy of such an experimental method the growth curves were studied this past year of two species of parasites, under controlled conditions.

Process of Elimination of Parasites.—The sheep were infected with parasites and killings were carried out from the second day in order to determine what populations were dislodged from the normal area of parasitism during the first few weeks of parasitism. Indirectly this knowledge has contributed towards understanding how parasites are accumulated. Past studies have shown that there is not a rapid turn-over of parasitism in which parasites are constantly lost and then being replaced by others. The present experiment confirms, to an extent, the previous conclusion that parasites are normally not quickly eliminated.

"Strain" and Susceptibility to Parasitism.—Some years ago a marked difference was observed in the degree of parasitism between sheep which seemed to be associated with breed strain. A slight degree of resistance was associated with a fleshy build of animal compared with extreme susceptibility in a lean type. A local sheep-breeder happens to be breeding two strains which conform to the types referred to. The work of following the course of parasitism in extreme representatives of these "strains" is in progress.

There are difficulties in defining what "strains" are, and dangers of confusing causal connections with events running parallel. There is no suggestion at the moment that selecting strains with a breed for resistance is a practicable possibility. Breed differences, however, in resistance to parasitism have been demonstrated in a number of instances by overseas workers.

The Role of Pregnant Ewes in Lamb Parasitism.—Opportunity was provided during the year, by the breeder referred to above, to make observations on this question.

Seasonal Nature of Parasitism in Sheep.—While the seasonal nature of parasitism in sheep has been established in Massey College studies over a number of years, observations continue to be made whenever opportunity makes it possible. This year information was provided from two flocks, one at Massey College and the other on the farm of a local farmer. In each case parasitism was of the traditional pattern with the difference that whereas the large stomach worm, Hæmonchus, was abundant in the Massey flock this species was absent from the other flock. Such information has a particular value on the question of the extent to which the pitch of parasitism may be forecast.

Relative Specific Infectability.—Sheep reared under shed conditions were infected with known populations of two species of round worms, with the object of determining what intensity of parasitism would result. This information is required to supplement data derived from the study of the seasonal populations of parasitic larvæ to which sheep are exposed in the field. Actual populations of larvæ on pasture have not been studied beyond a preliminary stage.

The Effect of the Parasites on the Host.—How injurious parasites are to sheep has been problematical for many years. Since farmers carry out their drenching programmes when parasitism is at a sub-pathological level, the question may be asked how "economic" is this. Previous Massey work has established the nature of the seasonal succession in parasitism. A following step is to establish the strategic times to apply measures of control. It is possible that drenching begins too early in the season. Not only have parasites been at sub-pathogenic levels and drenching, therefore, has been unnecessary, but the immunizing effect of the slow accumulation of parasites has been lost. Caution is necessary in advising farmers on this matter, and at present it is premature to advise the omission of early drenching.

This year a Massey flock was used, and the experiment is still proceeding, to establish the intensity at which symptoms of parasitic disease may develop. Data are being secured per medium of egg counts conducted on sheep fæces and regular weighings of sheep.

Special-purpose Pastures and Parasitism.—An opportunity has been provided to observe, by means of egg counts carried out on fæces of sheep, the bearing of special-purpose pasture grazing on the intensity of parasitism. Under this form of pasturing there is a heavy carrying-capacity and the problem is presented of how much improved nutrition counteracts the risk of greater parasitism through having larger than normal populations of sheep.

Anthelmintics.—Incidentally to another experiment, some information on the level of effectiveness of the drench, phenothiazine, was forthcoming. There were sufficient data to refute statements made in this country that phenothiazine was a solution to the internal-parasite problem. At least two important genera of parasites (*Trichostrongylus* and *Cooperia*) were found to be incompletely controlled by phenothiazine.

SCIENTIFIC LIAISON SERVICE

The Department's Scientific Liaison Offices in London, Washington, and Melbourne have been maintained at full establishment strength during the year. A large volume of technical and scientific information, not normally available through other channels and of special importance to research workers in New Zealand, has been received. In addition, the Department has been kept advised of modern overseas trends in scientific techniques and of scientific developments generally. In both London and Washington the association of the Department's Scientific Liaison Officers with the British Commonwealth of Nations Scientific Offices has greatly facilitated co-operation, and the approach, on a Commonwealth basis, to major projects of outstanding importance.

The helpfulness of overseas research organizations in so readily making available scientific information to the Liaison Officers is greatly appreciated.

London.—The London office is in charge of Dr. E. Marsden, Scientific Adviser, who is aided by an Assistant Scientific Liaison Officer and clerical staff. In addition to normal work, considerable time has been spent in interviewing applicants for scientific positions in New Zealand, and on some of the arrangements connected with the visit of scientists, both from the United Kingdom to New Zealand, and from New Zealand to the United Kingdom. The Scientific Adviser has attended a large number of Commonwealth Scientific Committees and has from time to time reported on general policy questions of a scientific nature in which New Zealand is interested.

Washington.—This office is in charge of a Scientific Liaison Officer, who has an Assistant Scientific Liaison Officer and a clerical staff. The professional officers have visited and reported on the activities of various research organizations engaged in work of direct importance to New Zealand, and have furnished detailed reports in a number of special cases.

Melbourne.—The Department is represented by a Scientific Liaison Officer. Technical information received from Australia is particularly valuable to New Zealand workers, since Australian conditions and problems are, in many cases, very similar to our own.

SCIENTIFIC PERSONNEL SECTION

Although a number of the more senior professional positions remain unfilled because of a lack of suitable applicants, in general the staffing position is more satisfactory than in the previous year. Science bursaries were awarded by the Public Service Commission to a number of promising officers of the Department to enable them to continue degree courses on a full-time basis. During the year, several post-graduate scholarships were awarded under the National Research Scholarship Regulations, which are administered in the Department.

In January, 1950, the National Research Fellowship Regulations 1950 and the National Research Scholarship Regulations 1950 were made, and the National Research Scholarship Regulations 1946 were revoked. The new Scholarship Regulations provide for increased emoluments. The fellowships will be awarded on a merit basis to applicants with research experience.

COMMONWEALTH AGRICULTURAL BUREAUX

The Commonwealth Agricultural Bureaux consist essentially of ten bureaux, two institutes, and a headquarters, all established in the United Kingdom but serving in particular all parts of the Commonwealth.

The main functions of the organization are the preparation and publishing of journals containing abstracts of literature relating to research in agriculture and forestry, and the preparation of technical communications. This service is particularly valuable to New Zealand, in view of the importance of these industries to our economic development. Participating Commonwealth Governments contribute to the support of the Bureaux and the funds are supplemented by the sale of Bureaux publications. New Zealand is represented on the Executive Council of the Bureaux by Dr. E. Marsden, Scientific Adviser, London. The Bureaux are represented in New Zealand by a liaison officer who is a member of the Department, and by official correspondents.

A Review Conference of the Bureaux, the first since 1946, will be held in the United Kingdom in 1950. The New Zealand delegates will be Mr. F. R. Callaghan, Secretary of the Department, Dr. J. F. Filmer, Director of the Animal Research Division of the Department of Agriculture, and Dr. E. Marsden.

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